TECHNOLOGY DEPT.

The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

VOL. L
NO. 1302

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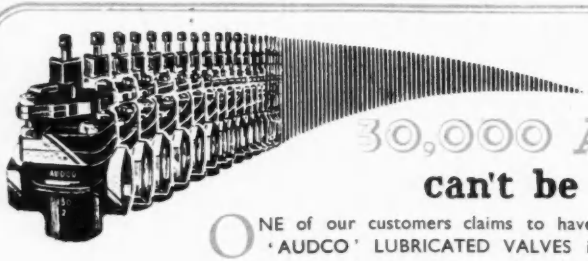

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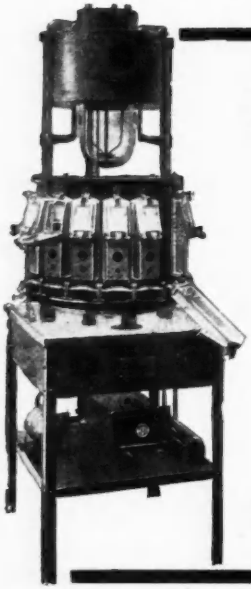

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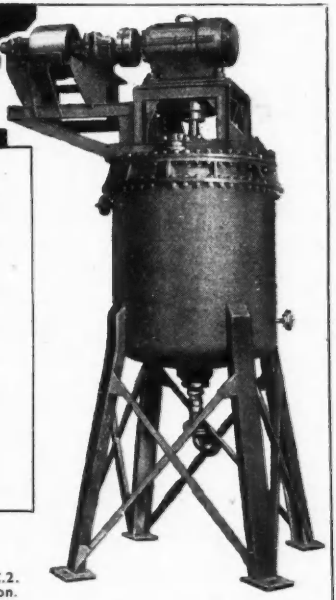

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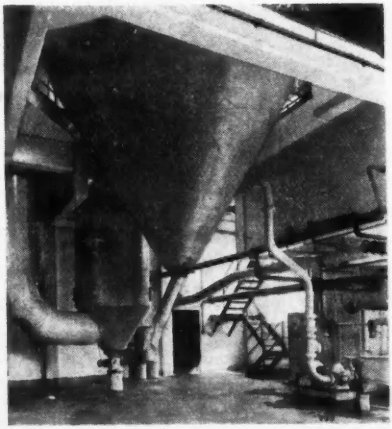

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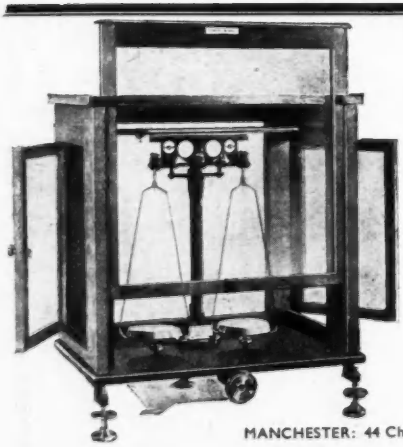

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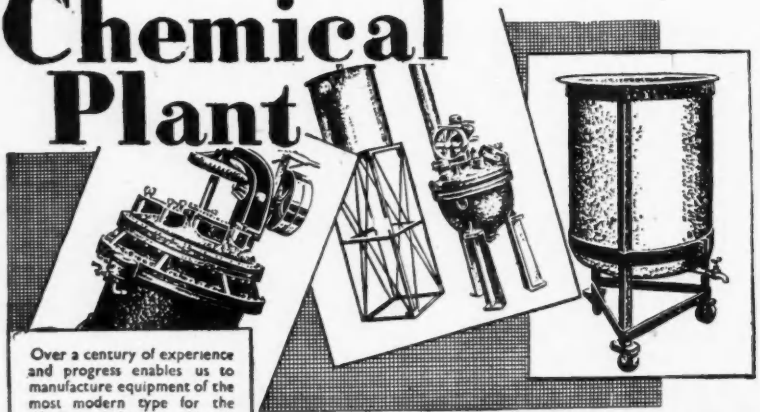

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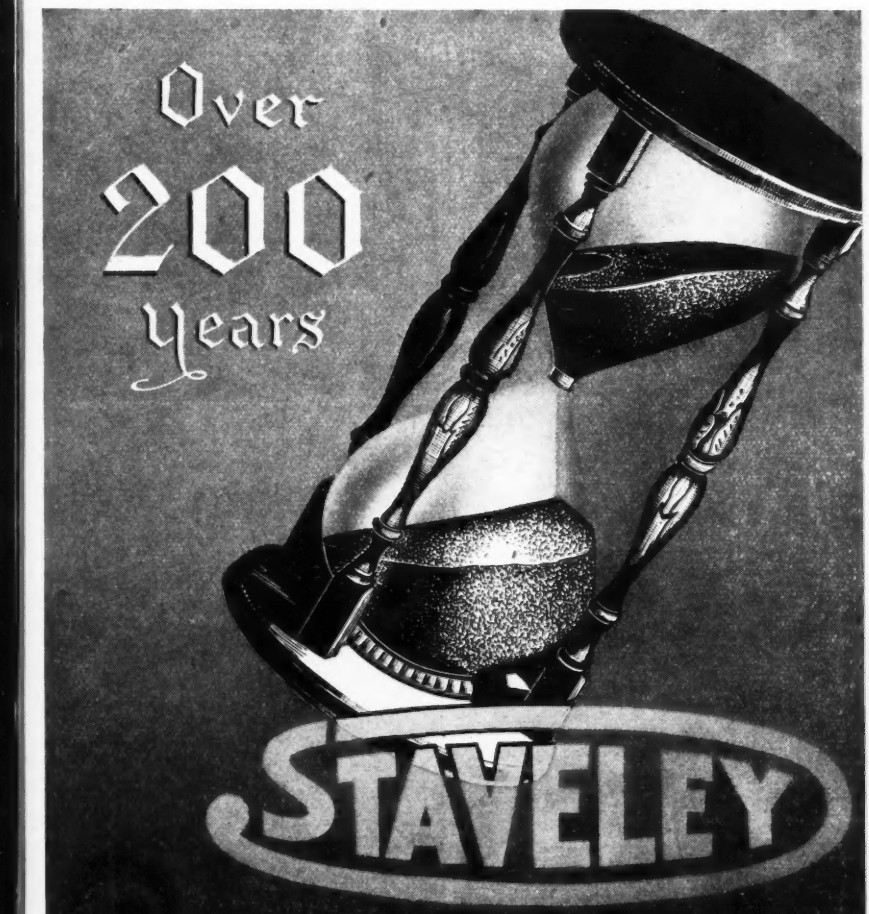

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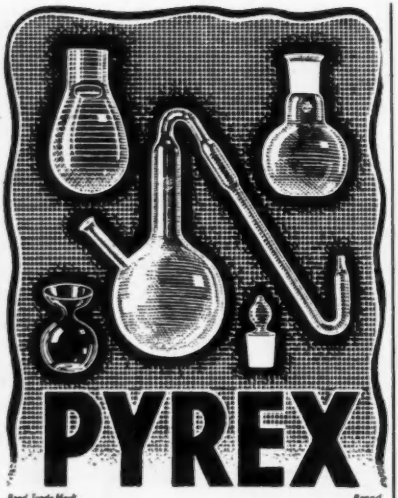

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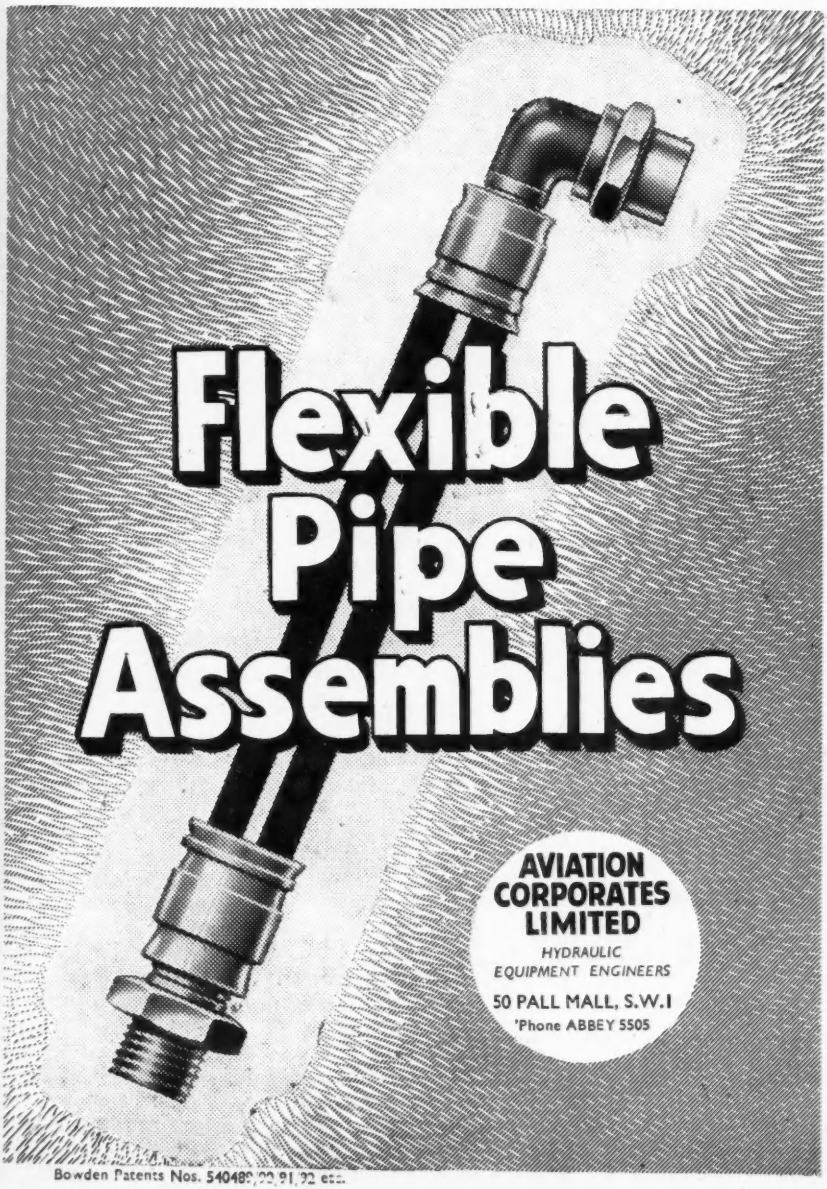
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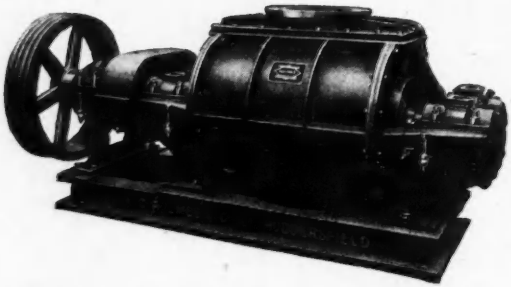

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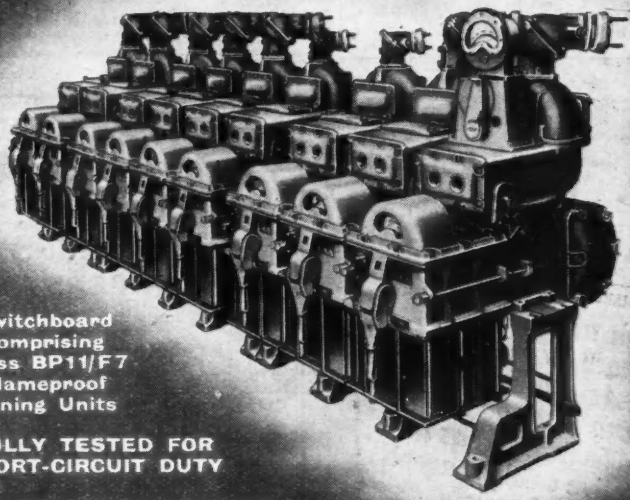

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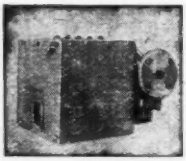

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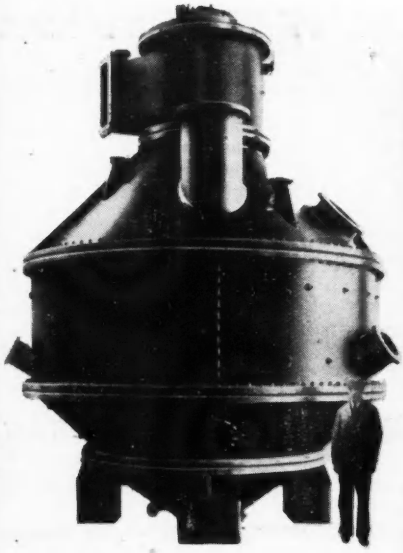

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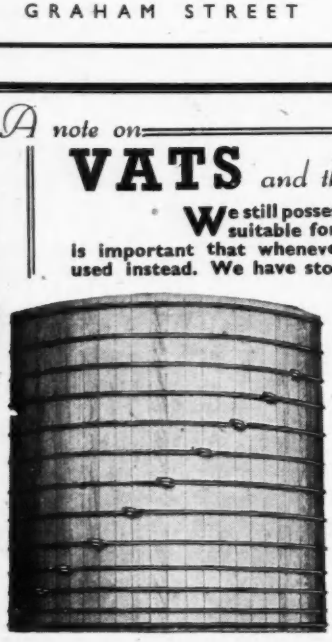

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Coal

COAL is used primarily as a fuel; it is our source of heat and power. By carbonisation certain products are obtained, which by reason of their comparatively small yield and financial value are termed by-products. From these, considerable sections of the chemical industry in the past have taken their origin. Ammonia and tar have been the principal sources, and although ammonia production from coal has given place to the synthetic product, coal tar is still the basis of our synthetic organic chemical industry. The importance of further developing our chief world supply of carbon has led to proposals to found a chemical industry, and perhaps several branches of the chemical industry, upon coal. In the early days of the century, Bedson discovered that coal could be separated by pyridine and chloroform into three fractions, and his discovery laid the way to much of the research that followed during the next 20 or 30 years on the constitution of coal. This considerable volume of work showed, for example, that several solvents had the power of resolving coal into constituents, and that by chemical treatment with chlorine, or a mild oxidant, or by distillation at very low temperatures, new bodies could be derived from coal, all of which were investigated solely with the idea of elucidating its chemical structure. Thus by resolution with solvents (or dispersion) coal was divided into hydro-carbons, resins, ulmins, and resistant plant remains. By mild oxidation of the mixture of insoluble ulmins and plant remains obtained by the pressure extraction of coal, these could be divided into alkali-soluble humic acids and plant remains. On direct oxidation of the coal by permanganate, benzene carboxylic acids were obtained by Bone and his colleagues.

No attempt was made to give commercial value to these discoveries and it is doubtful whether the idea occurred to anyone until the petroleum industry began to cast about for a method of using natural gas and the cracked gases from refineries. We have recounted in these columns how a great organic chemical industry is now about to be established, and in many respects has been established as a result. The petroleum chemists showed that intractable materials could be converted into unsaturated hydrocarbons, or nitrated or halogenated, and so forth, to produce bodies that could serve as the foundation for chemical synthesis. That gave the clue to the coal

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chemists and, as the oil interests do not appear ready to set up refineries in this country which would provide the basis for a similar development in the organic chemical industry, coal chemists began to foresee that we must turn to coal, our only source of carbon. In the meantime, Bergius had shown how to convert coal into oils, and Fischer and Tropsch had shown yet another way of doing the same thing. The possibility of founding a chemical industry on coal became clear. The researches of the pure scientists into the constitution of coal showed many of the ways in which coal could be split up into similar constituents or otherwise made amenable to treatment. The foundation was laid; the commercial structure had been started, though not yet on an economic basis.

At this stage the British coal industry decided to allot some half-a-million pounds to the chemical investigation of coal, through the British Coal Utilisation Research Association. This might well lead to the greatest development in the chemical industry in our time. It was thus appropriate for the first J. Arthur Reavell lecture before the Institution of Chemical Engineers to be delivered by the Director of B.C.U.R.A., Mr. J. G. Bennett. The subject taken was "Coal and Chemical Industry," and in the course of his address Mr. Bennett outlined the possibilities as he saw them. For the most part the possibilities as stated were the attempted commercial development of the processes and researches that have here been described. That programme involves the treatment of coal by many and diverse methods (as recorded in the later pages of this issue), as well as the direct use of coal or coke as a fuel for specialised processes. Having obtained simpler products or more reactive products by these means, there would remain the problem of finding how they could be worked up into intermediates leading directly to the production of commercial products. This huge programme not unnaturally leads Mr. Bennett to conclude that "the field is almost unbelievably wide, the harvest unlimited, and the number of workers still insufficient."

Recognising, as Mr. Bennet himself does, that we have yet a long way to go before the newer methods equal in their results and usefulness the older and tried methods, a word should be said about the use of coal as a combustible. Much has been said about the establishment of electro-chemical industries in this country, industries which are recognised as requiring cheap power. Electrothermal processes such as the manufacture of carbide show a high consumption of energy and thus can be developed on a large scale only in countries where cheap and abundant hydro-electric power is available. We have no adequate hydro-electric supplies and Mr. Bennett does not think we are likely to have. It may well be, however, that engineers may find more opportunity for developing power from the tides, etc., than Mr. Bennett as a proponent of coal usage would like to envisage. On the assumption that we shall not get large supplies of *cheap* electricity (and on this we should agree), the only way of establishing electrothermal industries here is to use fuel to produce the high temperature required.

In a significant passage, Mr. Bennett goes on to say: "The temperature of carbide production is about 2000°C., and at present this temperature is only obtainable in electric furnaces. Somewhat similar calculations apply to the manufacture of ferro-tungsten, ferro-silicon, phosphorus, silicon carbide and graphite. . . . The question arises whether these very high temperatures could not be obtained without the use of the electric furnace. . . . Some of the promising alternatives include: (1) Nearly theoretical combustion of coke with 19 to 20 per cent. CO_2, giving an effective flame temperature of about 1900°C.; (2) the use of highly preheated air, giving temperatures of over 2000°C.; (3) the use of oxygen, giving temperatures up to 2500°C.; (4) the use of oxygen and high preheat, giving almost unlimited temperature possibilities." There, it would appear, is a subject worthy of investigation. But it is a moot point whether gaseous fuels would not be better than solid fuels for these purposes. Hydrogen and carbon monoxide have flame temperatures in air of about 2000°C.; with adequate preheating of gas and air much higher temperatures can be obtained. Mr. Bennett is to be congratulated on a masterly survey of the known potentialities of post-war research into the chemical utilisation of coal.

NOTES AND COMMENTS

Over There

THE splendid news of the liberation of Rome was followed almost immediately by even more stupendous events —the invasion of France across the English Channel. The first landings were by all accounts completely successful, thanks to the skill and courage of the Allied sailors, soldiers and airmen. Behind the greatest armada that has ever sailed the seas was the massive effort, spread over the four years which have passed since Dunkirk, as millions of British hands forged, in endless stream, the tools of victory. Over many months the weapons of victory have been tested and perfected, and a great weight of equipment lies ready to sustain our attack as it develops. As Professor Blackett said a fortnight ago, it is now up to our fighting men to make full use of these weapons—it is their courage and determination that will settle the issue. It is up to the workers on the home front to see that nothing they need is lacking, and to meet every new demand that our fighting men make upon us.

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WHENEVER and wherever a Nazi has met culture during the German ocupation of Europe it has been his instinctive reaction, a reaction of which he has boasted openly, to release the safety catch of his rifle. It has been part of Nazi policy to destroy centres of learning, and as our invasion forces advance the task of restoring laboratories and scientific institutions in the liberated territories will grow in magnitude and urgency. It is fitting therefore that just before D-Day the president of the Royal Society should have announced a fund, to be known as the Horace Darwin Fund, to provide apparatus and materials needed for the restoration of scientific research centres in the countries at present occupied by the enemy. Sir Henry Dale stresses that such help will be required on a very large scale. He also emphasises that the offer of it from this country would certainly strengthen the bonds of collaboration with our own scientific community, and contribute to the promotion and maintenance of the ultimate European settlement. The fund will be in the keeping of the Royal Society, for administration as soon as and as rapidly as the liberation of the occupied countries, and the supply of the equipment required, make effective action possible. Contributions should be sent to the Treasurer of the Royal Society, Burlington House, London, W.1.

Indian Research

LAST year a symposium on the post-war organisation of scientific research in India was held at Calcutta, and the broad outlines of the problems involved were summarised most ably in a speech by Sir S. S. Bhatnagar, Director of Scientific and Industrial Research. An abridgment of his speech was published in *J. Sci. & Ind. Res., India* (1943, *2*, pp. 4-6), and in it, to begin with, are listed the main points which are to be considered before any useful plan can be made. Points which are of special interest as being peculiar to India arise partly from the fact that, thanks to the war, the country has been industrialised to a greater extent than ever before—though it must never be lost sight of that India is still vastly more concerned with agriculture than with any other form of industry. There will be available, however, a certain amount of structural steel and machinery for emergency plants, and war-time surveys, especially of non-ferrous minerals, have revealed the existence of invaluable opportunities for starting new industries. A huge increase in the application of fertilisers will be required to increase the food supply, and at the same time a long-term fuel policy must be developed to cope with the looked-for extension of industrialisation. These points have had the attention of the Board of Scientific and Industrial Research for four years and plans have already been prepared for establishing a National Chemical and a National Physical Laboratory, and Central Research Institutes for Glass and Silicates and for Fuel. Still more fundamental is the idea of founding a National Research Council of India, an advisory body concerned with the planning of scientific

work, and the supply of trained personnel. Sir Shanti ends his speech with the expression of the belief that the administration of research organisations should be left to scientists themselves, without any strangulating Government control.

The Bombay Plan

PUBLICITY for the Bhatnagar scheme is all the more essential today in view of the attention that has been directed to the so-called "Bombay Plan," the work of eight leading Indian industrialists, all of whom are either supporters of the Congress Party or are strongly nationalist in politics. This plan involves the expenditure of a large sum of money on a 15-year scheme of development in agriculture, social services, and public works. It postulates the existence of a national Government exercising economic jurisdiction over the whole of India, and inevitably awakens misgivings, on political grounds, in the minds of those who do not see eye to eye with Congress. But, whatever its faults, it has had the salutary effect of awakening all parties to the necessity of putting forward some scheme for India's future betterment, and the Moslem League has in view a plan of equally broad scope. The Central Government also has not been idle, and surveys of trading and industrial possibilities have been made. The whole complex will, at the very least, form a sound basis for a full discussion of India's future. Over all these rather optimistic plans, however, hangs a cloud of warning, to which Professor A. V. Hill, M.P., F.R.S., recently returned from India, has directed attention. The people of India, rapidly rising in numbers, must be fed; there is a grave danger that the Bengal famine will not be an isolated phenomenon. Overmuch attention must not be focussed on industrial development *too soon* to the detriment of agricultural research. India depends for her life on agriculture, and it seems to us that agricultural development must be the first consideration. Scientists should concentrate on the improvement of fertility by all the means in their power; industrialists should think in terms of transport and distribution. If the people of India starve, there will be no one to run the new laboratories or factories.

Scientific Liaison

ONE reform, perhaps apparently a minor one, but one which can be taken in hand at once without any risk, is the improvement of scientific liaison between India and Great Britain and between India and the other Dominions. India has been quite needlessly cut off from scientific and technical information which would have been freely available to its representatives in England, if it had had any. Even the war has had little effect in strengthening the liaison between technical men in the United Kingdom and India, and there are still no scientific or technical representatives of India in this country. Visits of a number of scientists, including Sir S.S. Bhatnagar, and of three of the proponents of the Bombay Plan, are promised for this year; and it is to be hoped that, even if they do nothing else, they will press for the establishment of a permanent Scientific Liaison Office to be maintained by the High Commissioner for India in London.

Colonial Research

A RAPID succession of reports on the subject gives one the impression that the pulse of research into colonial problems is quickening. Hard on the heels of the first annual report of the Colonial Products Research Council (of which a summary appears on another page) comes the Colonial Research Committee's report. Perhaps the most interesting point in it is the announcement of a scheme for creating a cadre of scientists capable of investigating problems of importance to the colonies. The scheme is initiated with the provision of 25 Colonial Research Fellowships, to be awarded on the recommendation of the Committee. Normally, these fellowships will be reserved for university graduates under 35 from any part of the British Commonwealth and Empire. Candidates, who must be research workers of some experience, should apply to the Secretary, the Colonial Research Committee, Colonial Office, Downing Street, London, S.W.1. The report also mentions the need to provide advice on industrial research, and hints at the likelihood of the D.S.I.R. being able to assist here.

Coal and Chemical Industry

The First J. Arthur Reavell Lecture*

THE lecture which is here abridged is the first of a series established by the generosity of Mr. J. Arthur Reavell, whose pioneer work in many branches of chemical engineering is known throughout the world. Mr. Reavell, as the lecturer stated in his foreword, has contributed greatly to the progress of coal research and it is therefore fitting that the first lecture in the series should have as its subject "Coal and Chemical Industry."

In his introductory remarks, Mr. Bennett stressed the outstanding importance to man of the element carbon, and he divided the carbon distributed on the Earth's surface into "static" and "dynamic" carbon. The former includes the carbon in limestone and other rocks, in sea-water, and in the atmosphere. Dynamic carbon is that contained in coal, petroleum, timber, and foodstuffs. Mr. Bennett gave comprehensive figures of annual carbon consumption, and of world energy consumption in terms of the coal equivalent. Of special interest was his division of the sources of energy into two categories, which could be likened to capital and income. When we use coal or petroleum, we are drawing on our stored-up reserves; food, timber, and water-power are currently produced and renewed.

In a brief history of coal utilisation, the lecturer showed that the appearance of coal as a dominant factor in human life was a comparatively recent event. In a period of some 200 years the "classical processes" of coal-utilisation were developed within the first 150, whereas during the last 50 years the dearth of really new developments in coal-utilisation was most marked—a situation not unconnected with the rise of the petroleum industry. The majority of such processes as have been developed recently have aimed either at deriving liquid fuels from coal or at enabling coal to replace liquid fuels directly. A successful oil-from-coal process must rely on local market conditions, or on artificial support (subsidies or import duties), or it must make, simultaneously with the liquid fuels, other products of such value as to offset the expenditure and loss.

Processes of Coal Utilisation

In the chemical industry the "heavy" sections are concerned with coal mainly as a source of energy, the "fine" sections require it mainly as a source of organic compounds. Coal-using processes may therefore be classified according to two factors. The first turns on the extent to which the carbon structure of coal is preserved, modified, or destroyed. The second is the use made of the energy of combustion, bearing in mind always that the ultimate fate of carbon in its dynamic forms is to revert to the static carbon dioxide or carbonates, with the liberation of thermal energy. In classifying coal-using processes it is necessary to recognise that the energy derived from combustion is used to bring about changes in the carbon structure of coal itself, or to induce physical or chemical change in other materials. Making use of these distinctions, it is possible to define the following six groups of coal-using processes:

(1) The coal substance is substantially preserved. High temperatures not used.
(2) The coal substance is modified, but not completely destroyed, by treatment with chemical reagents. High temperatures not used.
(3) The coal substance is modified but not destroyed, the principal agent being thermal energy. High temperatures used.
(4) The coal substance is completely disrupted by chemical agents. High temperatures not used.
(5) The coal substance is completely disrupted in one or more stages and the resulting product used as a chemical reagent. High temperatures used.
(6) The coal substance or modified coal substance is used solely as a fuel and the carbon converted as completely as possible to carbon dioxide.

One useful consequence of classifying coal-processing methods in this manner is that our attention is directed to the fact that at the present time the more violent processes dominate the field. Coal has been and still is used almost exclusively as a source of energy. About 95 per cent. of all coal mined in Great Britain is used in this way. Of the remaining 5 per cent., nearly the whole is coke used as a reducing agent in the blast furnace, which is an "ultra-violent" process. We have hardly any examples of processes in which coal is used without some kind of violent treatment. This appears the more strange when we compare coal with other carbon materials such as wood or textiles. Coal has so long been used almost exclusively as a fuel that it scarcely seems to have occurred to people that it might be used without being burned, or, at any rate, broken down by heat. There has also been a remarkable absence of processes developed on a commercial scale in which coal is made to enter into chemical

* Abridged from the first J. Arthur Reavell Lecture, delivered by Mr. J. G. Bennett, Director, B.C.U.R.A., at the 22nd annual meeting of the Institution of Chemical Engineers, in London on April 14.

reactions other than those of combustion. By reviewing coal processes with the help of the foregoing classification, we may be enabled to see better the possibilities which coal research holds for the chemical industry.

Non-Destructive Processes

The use of coal as a constructional material is at present virtually unknown, and since it is well known that coal has remarkable plastic properties, it is the more surprising that research has not been seriously directed to the utilisation of these properties for making moulded articles direct from coal. Carbon can form materials of great strength and with a wide range of elastic properties in the form of high polymers; and coal itself is certainly a high polymer, although we have not yet succeeded in identifying the monomeric units. It is, therefore, not unreasonable to hope that new and important uses for coal may be discovered in the form of processes which leave the carbon structure to a great extent unattacked. From the point of view of the chemical industry, such developments would have a double interest: cheap materials should be forthcoming with high chemical resistances which would be of value in chemical engineering; and the new processes themselves would be an addition to the range of chemical manufactures.

If substantially the whole of the coal substance could be directly converted into strong, solid materials, with strength and elastic properties equal to those of existing resins, and given the favourable prices which it should be possible to realise, an entirely new outlet for anything from 4 to 8 million tons of coal a year could be created, and we should save imports of timber and iron ore to the value of £10 to £20 millions a year. In this direction there is clearly a research objective of the utmost importance for both the coal and the chemical industries.

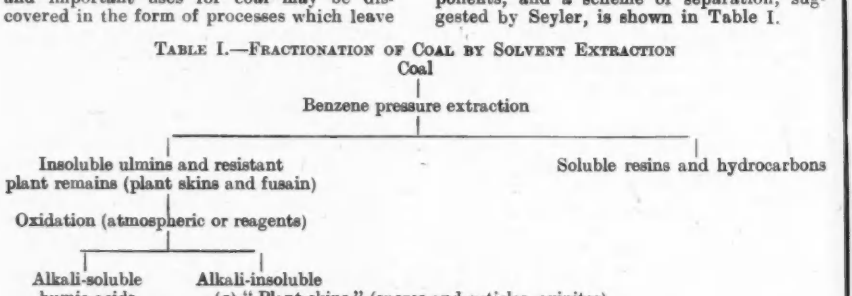
The separation of bituminous coal into its petrological constituents can be regarded as a process of the first group. Each of these components appears to have a well-defined chemical behaviour, and if means of separating them can be developed certain of the components may prove to have special value for chemical processing.

There is a considerable scientific literature dealing with the treatment of coal with organic solvents, and with the usual chemical reagents; but no single process of commercial importance has yet emerged.

Solvent Extraction

The use of solvent extraction or dispersion may aim either at the separation of the inorganic and organic constituents of coal or at the partial breakdown of the latter into simpler compounds of commercial value. Bituminous coal can be separated by the so-called "rational analysis" of Wheeler and Francis into proximate chemical components, and a scheme of separation, suggested by Seyler, is shown in Table I.

TABLE I.—FRACTIONATION OF COAL BY SOLVENT EXTRACTION


Coal
Benzene pressure extraction
Insoluble ulmins and resistant plant remains (plant skins and fusain)
Soluble resins and hydrocarbons
Oxidation (atmospheric or reagents)
Alkali-soluble humic acids (regenerated ulmins)
Alkali-insoluble
(a) "Plant skins" (spores and cuticles, exinites)
(b) Highly "carbonised" materials, fusain components.

The resins and hydrocarbons can be fractionated, if desired, in a variety of ways, but this is not part of the normal "rational analysis."

In practice the solvent fractionation of coal would be combined with ash separation, as in the Pott-Broche process, one of the few developments which have reached the commercial stage.[1] This process uses coarsely ground bituminous coal extracted, under pressure, with a mixture of tetralin and naphthalene with tar acids. The resulting extract, which contains 90 per cent. of the original coal substance, has a high hydrogen content and is said to be easy to hydrogenate to give an 80-octane motor spirit. A 29-ton-per-week plant was installed in Germany before the war, the product being intended for extensive trials in the Bergius plant. The process is now reported to be used in Germany on a large scale.

The Uhde[1] process is on the border-line between Groups (2) and (3), for it operates at temperatures between 390° and 400°C., at which pyrolysis of the coal substance sets in. A high pressure (400 atm.) is used, and the process gives mainly acids and

aromatic hydrocarbons, of which about 60 per cent. are liquid or gaseous.

The oxidation of bituminous coals under carefully controlled conditions gives a mixture of alkali-soluble and alkali-insoluble compounds, namely, ulmins and resistant plant remains, exinites and fusain components. The treatment of coal with chlorine[2] has important possibilities which, probably from lack of financial resources, have not been fully explored.

A survey of this field gives one the impression that the techniques used by the investigators have not been adequate and that the discouraging results have led to a general abandonment of work. Recent advances in organic chemistry have, however, made available methods of attack so varied and so specific in their action that it is legitimate to expect that a fresh start, made with adequate resources, may have very important results. Coal treated in these ways may well become an essential source of "humus substitute"; and colloid chemistry and biochemistry will have contributions to make.

High-Temperature Processes

The importance of coal carbonisation needs no stressing. Some 40 million tons annually are carbonised at atmospheric pressure in coke ovens and gas works. The high-temperature processes predominate, being responsible for 98 per cent. of the coal carbonised in Great Britain. Processes at pressures greater than atmospheric, under reduced pressure, and in organic solvents are almost entirely in the experimental or development stage as far as, at any rate, Great Britain is concerned. In carbonisation at atmospheric pressure, the yields of different compounds are markedly influenced by the temperatures used. For the purposes of the chemical industry, the interest in coal carbonisation turns mainly upon the character of the coal-tar products. These are mainly aromatic hydrocarbons, phenols, and bases. Chemical industry and agriculture derive about half of their ammonia requirements and about one-fifth of their sulphuric acid from coal carbonisation. Although upwards of 200 different compounds have been identified in coal tar, the great majority of these are either present in such small quantities or have so low a commercial value that they play no significant part in chemical industry. Coal gas contains constituents of great potential value to the chemical industry, and Levinstein[3] has recently urged that the recovery of ethylene should be regularly practised. He argues that ethylene has now become one of the most important raw materials, and we have no satisfactory alternative supplies in this country. He also, rather more doubtfully, suggests that the methane recoverable from coal gas could be better used as a chemical raw material than as a fuel.

It is unnecessary to elaborate further the picture of coal carbonisation and coal-tar refining. The facts are widely known and have frequently been compared disparagingly with those of petroleum refining. If coal is regarded as a raw material from which high-value chemical products are to be derived, it must certainly be admitted that the process of coal carbonisation is extremely crude. Since, however, the aim of carbonisation is to produce improved fuels, coke and gas, the fact that the yield of chemical raw materials is low is not a fair justification for criticism. Nevertheless, for the purpose of our present inquiry, the essential question is whether the pyrolysis of coal could, under appropriate conditions, be made to yield a larger range of more valuable products.

In order to answer this question it is necessary to consider the chemical composition of coal and the various carbonisation systems summarised at the beginning of this section of the lecture. Though mainly aromatic in character, coal must contain a proportion of the aliphatic groups, as is shown by the quantity of paraffins obtained from low-temperature carbonisation. With such a material, it should not be beyond the powers of the organic chemist to recover more than 1 per cent. or 2 per cent. of the simpler hydrocarbons, phenols and bases and to make less gas and polycyclic hydrocarbons of little value and, above all, less coke.

The petroleum chemist no longer relies solely on fractional distillation, but uses catalytic cracking, polymerisation, isomerisation and the other powerful and delicate techniques. Compared with these developments coal carbonisation and coal-tar distillation are primitive and crude. Scientific research into petroleum refining during the past 20 years has been conducted on at least 100 times greater scale than research into the production of tars by coal distillation, including all the work that has been done on low-temperature carbonisation methods. The result is that modern petroleum refining yields 80 per cent. to 90 per cent. of valuable products, while less than 1 per cent. of the non-gaseous products of coal carbonisation are worth more than £3 per ton at 1938 prices.

A Coming Change

So long as coal carbonisation is conceived mainly in terms of the production of fuels, there is little incentive to increase the yield of hydrocarbons and to meet the other needs of the chemical industry. There are, however, important developments coming into view as a result of the far-sighted research policy of the British gas industry. The Gas Research Board is working out processes

of coal gasification which should certainly lead to a great change in the yield of by-products and in their value to the organic chemist. The potential value to British industry of these advances is incalculable, but they do not by any means exhaust the possibilities of research into the heat-treatment of coal. So far as is known, the primary aim of the Gas Research Board investigations is to give increased flexibility to gas manufacture and to solve the problem of coke disposal. The conversion by heat-treatment of coal into products of value to chemical industry is an objective which has not yet received attention on a scale commensurate with its importance.

Reference has already been made to the distillation of coal from an oil dispersion, as is done in the Uhde[1] and Knowles[4] processes, but even these are little more than promising guesses, and not the result of systematic research. The whole group of processes involving partial disruption of the coal substance by heat and by the application of energy in other forms requires research on lines which will break new ground and open up new methods of treatment. Scientific research is only one aspect of the matter, for new processes will almost certainly be more costly than simple carbonisation and their justification will lie solely in the commercial value of the products they yield.

Chemical Disruption

The processes of the fourth group are essentially chemical in character. The coal substance is attacked by an agent which destroys the bonds that hold it together as a solid. A typical example is hydrogenation by the Bergius method. The process of hydrogenation, so far from consuming energy, actually liberates heat. At the same time the process is wasteful because it involves the use of large quantities of expensive hydrogen and because the capital charges are heavy owing to the extremely high pressures employed. The effect of hydrogen is, no doubt, to destroy the oxygen, sulphur, and nitrogen bonds which hold the coal substance together, so that in place of a solid the product is a mixture of liquids and gases, and in place of the raw coal containing 15 per cent. to 20 per cent. of oxygen and other elements we get hydrocarbons virtually free from oxygen sulphur and nitrogen. Regarded as a method of producing liquid fuels from coal in competition with petroleum, the hydrogenation process can scarcely be economic. It requires several tons of coal to make 1 ton of good motor or aviation spirit, as compared with less than 1.1 to 1.2 tons of crude oil needed in a modern oil refinery. There are many possibilities of research on lines quite outside those hitherto followed in the development of the Bergius patents. It must not be forgotten that the very existence of the hydrogenation process is a safeguard against an undue rise in liquid fuel prices in countries poor in oil but rich in coal. If the price of petrol (without tax) were to rise to 1s. 6d. per gallon and coal to be available at 30s. per ton, it would be economical, even with present-day technique, to make petrol from coal by hydrogenation.

Oxidation of Coal

Although hydrogenation is likely to be the most interesting type of process in this group, there are also possibilities along the lines followed by Bone and others[5] in regard to the oxidation of coal by permanganate or other strong agents to benzene carboxylic acids. Bone and other research workers were mainly concerned with establishing the constitution of coal, and do not seem to have been interested in finding products of possible commercial value. As things turned out, they achieved only partial success. But because a particular line of research has failed in the past, it is quite wrong to assume that it is not worth fresh investigation at a later date when more refined technical methods are available. This is particularly the case with coal chemistry, for we have methods of studying coal to-day of which the earlier generation of investigators knew nothing.

The progress of industrial research depends upon advances in the basic techniques developed by pure science, and we are still only at the beginning of an understanding of the physical and chemical behaviour of solids. It is usually overlooked that the greater part of our knowledge of changes in the properties of matter refers to the reactions of gases and liquids. A further difficulty of an equally fundamental character lies in the fact that coal is one of the few natural products which have so far defied the attacks of the organic chemist. For at least a century chemists have been trying to understand how coal is put together and how, therefore, it can be taken apart. It is only very recently that it has become clear that this kind of investigation must fail, and why. The discussion at the Conference held at the Royal Institution last June made it clear why the organic chemist had been unable to solve the riddle of coal, and why we should make use of the new instruments of physical chemistry, colloid science, and coal petrology. We are only at the starting point of modern coal research, and it will be several years before we reach the stage at which new developments on a large scale can be expected.

There are almost unlimited possibilities in this fourth field of coal treatment—essentially chemical methods of breaking coal down to simple organic bodies—provided that the necessary chemical research is placed on a proper footing and it is empha-

sised that the objective is to develop new products of high commercial value and not merely liquid fuels.

High-Temperature Disruption

In the fifth group of processes there are two principal sub-groups :—

(a) Processes involving complete disruption of the coal substance to simple chemicals which readily undergo further reaction.

(b) Processes in which the coal substance is completely disrupted, serving simultaneously as a source of energy and as a chemical reagent.

The best-known process of the kind is that due to Fischer and Tropsch, in which coke is completely gasified with steam to give a mixture of carbon monoxide and hydrogen, and the proportions are adjusted by a catalytic conversion. The resulting so-called "synthesis gas" is then passed over nickel or cobalt catalysts, suitable precautions being adopted to remove the heat of reaction, when a mixture of hydrocarbons, called by Fischer "*Kogasin*," is produced. According to statements in the German technical press, the process has recently been greatly improved, and now produces not only straight-chain paraffin hydrocarbons, but also the more valuable isomeric forms. The principal defect of all these processes is that they are wasteful of the coal substance. About half the coal is lost in making synthesis gas, and only part of the synthesis gas itself is turned into liquid products. The main source of loss in each case is the conversion of carbon to carbon dioxide, and of hydrogen to water. In consequence of these losses it takes several tons of coke to produce 1 ton of liquid and solid hydrocarbons.

The objective for future research must be, first and foremost, the elimination of this waste. As compared with the 30 to 40 per cent. yield of high-value hydrocarbons from coal by present synthetic methods, modern petroleum refining gives something like 80 per cent. of desired products from crude oil. When the fact that crude oil at the well is actually cheaper than coal at the pithead is taken into account it becomes evident that there is little hope of synthetic fuel-oil processes becoming established so long as there is this great disparity in efficiency.

The processes of the second type are those in which coal is used simultaneously as a chemical reagent and a source of energy. By far the oldest and most important of such processes is the smelting of metals. Twenty million tons of coal a year are used for making blast furnace coke in Great Britain alone. In the blast furnace, the coke is both a chemical reagent and a source of energy. In the same basic group are the processes for the manufacture of carbides, of which the most important in terms of tonnage is calcium carbide for the manufacture of acetylene. In this case, however, the necessary energy cannot be obtained directly from coal, and it is necessary to generate electricity in order to achieve the high temperatures required. This process, therefore, properly falls to be considered in the next group, in which the use of coal is primarily or solely to supply energy. It is, however, important to note that the manufacture of calcium carbide involves a serious wastage of coal, for it takes 12 to 14 tons of coal and coke to make one ton of pure acetylene *via* thermally generated electricity.

The basis of these coal-using processes is the commercial value of the product obtained. Where this can be sold at a high price, the losses inherent in the process can be faced with equanimity. When, however, it is a question of competing with petroleum derivatives, the economic factor assumes an decisive importance. Research must therefore be directed at least as much to the *physical* problem of conserving the energy as to the *chemical* problem of controlling the product.

In planning a scheme of research into the manufacture of synthetic products from coal, the aim is to produce a sufficient proportion of high-value materials to raise the total financial return of the process to a level which will make it economic without undue increase in the capital or operating costs.

Coal as a Source of Energy

The sixth and last category of coal utilisation processes comprises those in which the whole of the coal substance is discarded as carbon dioxide, water vapour and other oxides, and only the heat of combustion is turned to account. There are three chief ways in which this is done :

(a) Heating of product by the combustion gases : (1) direct; (2) producer gas.

(b) Generation of steam : (1) Steam used for chemical processes; (2) steam used for heating only.

(c) Generation of electrical or mechanical energy.

The chemical reactions in which energy derived from coal is used in one of these three ways cover not only almost the whole field recognised as the chemical industry proper but also many other processes. In each case the efficient production and utilisation of heat has a more or less important influence on economy. Table II shows the approximate coal consumption of some of the main industrial groups in which chemical processes are used and the overall thermal efficiency where this is known. The figures given are not more than a fair attempt to give an idea of the order of fuel consumption involved, and it is hoped that

the chemical industry will turn more of its attention to this aspect of process economy.

In the chemical industry proper there are many processes involving large energy consumption—such as lime-burning, and the manufacture of primary materials such as ammonium sulphate, soda ash, chlorine, and calcium carbide. In all cases the problem for research and technical development divides into two parts. The first is fuel economy in its broadest sense, and the second is the discovery of new processes which are inherently more efficient. A full discussion of the possibilities involved would be equivalent to a review of the whole field of chemical industry and would go far beyond the limits of the present lecture. There is, however, one question of much importance from the point of view of our future as a nation in the coming age of chemical progress. This refers to the prospects of our being able to develop those chemical processes which normally depend for their economic success upon cheap and abundant supplies of electrical energy. Although the greater part of the world's electric power is derived from coal the cheapest source of supply for continuous use is at the hydro-electric station adjacent to large water catchments. Starting from *coal*, the production and use of electricity is a terribly wasteful form of energy conversion. It is well known that in the average power station only about one-fifth of the energy combustion of the coal is converted to electrical energy.

Although certain power stations exceed 28 per cent., the average overall efficiency of electrical generation for the whole of Great Britain is under 22 per cent., and after allowing for the losses involved in transmission and in transforming down to low voltage the industrial consumer receives only about 18 per cent. of the energy theoretically obtainable from the coal.[6] Not only does the generation of electricity in present-day plant sacrifice some 80 per cent. of the *thermal value* of the coal, but it also involves the loss of what might be called *chemical value*. Even the meagre yield of valuable chemicals obtainable by carbonisation is sacrificed when coal is burned in a present-day power station. The use of energy in the form of electricity is thus doubly wasteful of our coal resources. It involves a loss, on the one hand, of energy, and on the other, of chemical materials. That the electrical industry has grown up and enjoys an outstanding prosperity notwithstanding these difficulties, is due to the very high price the consumer is prepared to pay for the advantage of using energy in so convenient a form as electricity. Nevertheless, when we switch on the electric power we must remember that its use involves the consumption of about six times the amount of coal that would be needed if we could employ the whole of the heat of combustion directly. This stubborn fact sets limits to the possible use of electricity for industrial purposes under present conditions. It is unlikely that district heating and other methods of utilising power-station waste heat will materially reduce the cost of electric supply, for the capital charges will largely absorb the fuel saving.

There are, however, extraneous considerations, and in order to assess the prospects of establishing new electrochemical processes in this country we have to consider the basic cost of electrical generation. This can be split up into two components: (a) the cost of the energy to be converted into

TABLE II.—FUEL CONSUMPTION OF A FEW TYPICAL INDUSTRIES IN WHICH CHEMICAL OPERATIONS ARE USED

	Annual Consumption, tons (1935)	Fuel consumption per ton product	Thermal efficiency %
1. Artificial and natural silk	611,000	7 to 26 tons	<10
2. Brewing and malting	711,000	11 cwt.	Very low
3. Brick and fireclay	4,636,000	Bricks: 2 to 4 cwt. Fireclays: 11 cwt.	2 to 5
4. Biscuits	101,000	4 to 9 cwt.	4 to 5
5. Chemicals, dyestuffs and drugs ...	3,029,000	Too much variation to permit average figures to be given	—
6. Cement	1,960,000	4 to 6 cwt.	40 to 50
7. Cocoa and confectionery	247,000	4 to 12 cwt.	4 to 5
8. Distilling (spirit)	201,000	18 cwt.	—
9. Fertilisers and glue	194,000	8 cwt.	—
10. Glass	887,000	1¼ tons	10
11. Lime	1,400,000	4 cwt.	20 to 50
12. Paper (1938)	2,501,230	20 cwt.	48
13. Petroleum refining	2,089,000	—	—
14. Soap, candles and perfumery ...	596,000	12 cwt.	—
15. Sugar, and glucose	1,063,000	2¼ cwt.	—

electricity, and (b) the cost of the conversion. In order to appraise the position of coal we must take into account the alternative of water power, since at first it might seem that with water available for nothing, a hydro-electric station should always give lower costs than a thermal station where coal, though cheap, represents a definite item in the cost. As a matter of fact, hydro-electric stations are always much higher in capital cost than thermal stations, and the capital charges, after a certain point, can become so high as to wipe out entirely the advantage of free water. In comparing hydro-electric with thermal stations it is not sufficient to calculate only the cost of the direct installations, but account must also be taken of such factors as transport facilities and distance from markets. A hydro-electric scheme in a remote mountain district may require large-scale civil engineering works in the form of harbours or roads and railways. These difficulties are only removed when a hydro-electric project can be planned to include the establishment of new consuming communities in the area, as was done in the case of the Tennessee Valley Authority.

Comparison of Costs

Hutton and Roskill[1] showed, in a most valuable analysis made just before the outbreak of the present war, that if a thermal station could be built at £15 per kW installed, it could just compete with a hydro-electric station costing £50 per kW installed, provided coal costing 20s. a ton was used. Now, the cost of hydro-electric stations varies enormously according to the conditions of the site. The first great station to be built in this county was naturally erected on the most favourable site to be found—at Kinlochleven, where the cost of construction was under £30 per installed kW. The West Highlands scheme is estimated to cost £52 per installed kW at pre-war contracting costs. Gibson has estimated that the Severn Barrage scheme would have cost about £60 per kW installed. This figure was calculated as far back as 1920, when costs were much lower than they are to-day. These figures are important because they show that, as far as Great Britain is concerned, there is little prospect of getting electric power on a large scale at cheaper rates than can be obtained from thermal stations, and thermal stations involve a very serious waste of coal. It is therefore unlikely that we shall be able to compete successfully as regards electrochemical processes in countries where the capital charges on hydro-electric plant have been low per kW installed or where the cost has been heavily subsidised by low-interest loans from the State. As against this, Roskill has rightly emphasised the importance of taking delivered rather than ex-works costs into account. This applies particularly to hydro-electric plants in remote parts of the country, where ancillary facilities, such as harbours, railways and roads should be added to the basic cost.

Quite apart from considerations of cost, it must be borne in mind that the total hydroelectric potential of Great Britain, including all feasible inland tidal schemes, is only a small proportion of the capacity of thermal stations already in being. According to *Energiequellen der Welt*, our potential is 850,000 h.p. of which slightly under one-half had been developed by 1935. The World Power Conference statistics give an installed capacity of generators in "authorised" hydro-electric plant of 288,000 kVA.

Electrochemical Industries

These factors must be taken into account in assessing the value of large-scale electrochemical plant in this country. The recent report of the Select Committee on National Expenditure has raised doubts whether the electrical production of magnesium in this country is likely to compete with that of American and Continental sources. The same applies to calcium carbide. The probable average practice for carbide manufacture in this country would require 4500 kWh and 1 ton of coke for 1 ton of 80 per cent. carbide. This is equivalent to some 14 tons of coal per ton of pure acetylene, or a carbon conversion efficiency of 8 per cent. This represents a very serious loss, which would handicap a chemical industry that was obliged to rely on home-produced carbide as a raw material. The temperature of carbide production is about 2000°C., and at present this temperature is obtainable only in electric furnaces. Somewhat similar calculations apply to the manufacture of ferro-tungsten, ferro-silicon, phosphorus, silicon carbide, and graphite, all of which require large quantities of energy. The question arises whether these very high temperatures could not be obtained without the use of the electric furnace. There are outstanding prospects for coal research in this direction. Some of the promising alternatives include:

(1) Nearly theoretical combustion of coke with 19 per cent. to 20 per cent. CO_2, giving an effective flame temperature of about 1900°C.

(2) The use of highly pre-heated air, giving temperatures of over 2000°C.

(3) The use of oxygen, giving temperatures up to 2500°C.

(4) The use of oxygen and high pre-heat, giving almost unlimited temperature possibilities.

Research in progress shows that (1) and (2) should be capable of realisation in the near future. The use of oxygen in place of air, or oxygen enrichment up to 60 or

80 per cent., opens up possibilities which have been insufficiently appreciated hitherto. The cost of oxygen will be a decisive factor. Contrary to statements which have been widely published, it does not appear that the Kapitza method will lead to reduced power consumption as compared with the normal process. There are, however, considerable possibilities in the use of combined systems where mechanical energy can be obtained at relatively low cost. These should make it possible to obtain an 80 : 20 oxy-nitrogen, which could be used to produce very high temperatures. It is also possible that electrolytic production could be made economic as an off-peak load if markets could be found for quantities of oxygen equivalent to those for hydrogen.

Furnace Research

The problem of dispensing with electricity depends not solely upon the generation of high temperatures, but even more upon the construction of furnaces in which they can be used. This is a task of refractories research, and many years ago Hutton urged that research into "super-refractories" should be regarded as urgent. There are several oxides, carbides, and silicates which will withstand temperatures exceeding 2000° C., and carbon itself is the most refractory material of all, keeping its solid form up to temperatures well above 3000° C. The engineering problems of very high-temperature chemistry, apart from the electric furnace, are largely new and unsolved, but there is no reason to suppose them insoluble. In any event, developments in these directions are more likely to provide British chemical industry with cheap acetylene and other vitally important raw materials than the orthodox electric-furnace methods. It is also necessary to remember that the last word has not been said on the subject of electrical generation from coal: we may yet find it possible to avoid the losses inherent in the heat-engine cycle and generate electricity directly. Apart from these ultimate possibilities, reference should be made to the gas or powdered-coal direct-fired turbines. It is, however, very doubtful whether these systems will radically change the position, for they are not exempt from the losses inherent in the heat-engine.

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New Colour Index

Loose-Leaf Form Adopted

At a special meeting of the Manchester section of the Society of Dyers and Colourists on May 12, with Dr. H. A. Thomas, B.Sc., F.I.C., in the chair, the compilation of the new Colour Index and the form of its presentation were discussed. Among the contributors to the discussion were Messrs. E. B. Adams, M.Sc., F.I.C. (English Sewing Cotton Co., Ltd.), N. Hamer, A.M.C.T. (Turnbull & Stockdale, Ltd.), O. S. Rhodes, M.Sc., A.I.C. (Tootal Broadhurst Lee Co., Ltd.), G. S. J. White, B.Sc. (I.C.I., Ltd., Dyestuffs Division), A. W. Doyle (Department of Textile Chemistry, Manchester College of Technology), and J. D. Webster (Calico Printers' Association, Ltd.).

The first Colour Index, published in 1924, constituted the first collection of information concerning dyestuffs in an unbiassed form in the English language. It was not competitive with Schultze, but it did supply a long-felt want at the time. It contained much unusual information, especially with regard to constitutions and the equivalents of dyestuffs produced by different manufacturers. In addition, it became the means by which the Society of Dyers and Colourists evolved from a local industrial and technical society to the status of an accepted world-wide authority on dyestuffs, their uses and manufacture. There were no copies of it now available for the general public, although there were still a few stored away for emergency purposes. The Publications Committee of the Society, therefore, decided to proceed with the publication of a new Index; and it was resolved that the new volume should contain more information regarding the properties and uses of dyestuffs, and be much less concerned with their process of manufacture. It was suggested that the new work should be supplied in a loose-leaf form, which would enable subscribers interested in only a narrow range of products to purchase merely those parts they needed, and would facilitate the assembling of their required information in any desired order.

It was suggested that dyestuffs should be referred to by serial numbers, though the old Colour Index number would be stated also. The new volume would be an authority on the fastness of dyes, and, possibly, their uses, and particularly with regard to fastnesses to light and washing. Almost no non-textile uses were mentioned in the old Index. Anything in the way of advertising or boosting would be carefully avoided, and an important consideration was that, being in card index form, it could be kept consistently up-to-date.

A.C.S. Meeting at Cleveland

Summary of Industrial Division's Papers

THE Division of Industrial and Engineering Chemistry of the American Chemical Society held a five-day conference in Cleveland, Ohio, in April. Abstracts of some of the papers then presented have now reached us. One of the most interesting sessions discussed the chemical outlook for the post-war period. Foreign trade was the subject of one of the papers, and the speaker, Mr. J. B. Glenn, president of the Pan American Trust Co., New York, suggested that the largest expanding markets would lie in Latin America and the Far East, where former Axis-controlled chemical companies would be held for local enterprise. Latin America would be of particular interest, he said, in view of the transplanting of many tropical crops, of importance to the chemical trade, from Japan, Malaya and the Dutch East Indies. He predicted that the United States could attain and hold the largest volume of foreign trade in all the world provided they maintained private enterprise, kept their workmen employed and lowered the national debt.

The future of technical education appears to be receiving in America the same close attention which it is attracting here. The president of the Polytechnic Institute of Brooklyn, Mr. H. S. Rogers, spoke of the need for closer liaison between educational institutions and industry. He did not anticipate, however, any great change in the undergraduate engineering and professionalised chemistry curricula. The expansion of research during the war might be expected to stimulate further graduate study both in full-time and part-time research programmes.

A paper by Mr. D. M. Sheehan of the Monsanto Co., St. Louis, Mo., dealt with the financial problems of the post-war period. During the war, he said, economy had often been subordinated to expediency, and this, coupled with high taxes, had accentuated the general disregard of business costs. Competition after the Armistice would make it more important than ever that all costs should be carefully controlled. The present high taxes meant there was little money left for use in building the reserve needed to meet unforeseen contingencies. Tax laws should permit accumulation of such reserves.

Decomposition of Cyclohexane

A number of general papers were presented at the opening session. One of them, by G. L. Sumner and Lloyd Berg, Gulf Research & Development Co., Pittsburgh, Pa., dealt with pyrolysis of cyclohexane. The non-catalytic thermal decomposition of cyclohexane has been investigated over a temperature range of 1300°-1600°F. and contact times of 0.1-1.0 second. The work was carried out in glass equipment based on a quartz pyrolysis-tube. Cyclohexane feed rates were varied from 1 to 55 ml. per minute. The use of steam as a diluent was also studied. Pyrolysis products consisted of hydrogen, methane, ethane, ethylene, propylene, isobutylene, butene-1 and 2, butadiene, and an undetermined liquid residue. The results indicate that increased temperature and lengthened contact time have essentially the same effect upon the nature of the gaseous product; extremes of either of these tend to favour the exclusive decomposition to hydrogen, methane, and ethylene. The maximum yield of butadiene is obtained at conditions which give a depth of cracking equal to 35-45 lb. of C_3 and lighter per 100 lb. of cyclohexane charged. The maximum amount of butadiene obtained is 12 per cent. per pass using steam as a diluent, and 9 per cent. per pass in the absence of a diluent. Maximum ultimate yields in either case are 25-35 per cent. Short contact time tends to favour higher concentration of the butadiene in the C_4 fraction.

Commercial Pyridine Bases

"Coal-Tar Bases, their Chemistry and Properties" was the title of a paper by F. E. Cislak, Reilly Tar & Chemical Corp., Indianapolis, Ind. He used the term coal-tar bases to refer to the heterocyclic nitrogen bases obtainable from coal tar, commonly called pyridine bases. During the past few years, the coal-tar bases have emerged from the realm of laboratory curiosities and become important industrial chemicals. Continued research on coal tar has resulted in the development of processes for isolating, in pure form, many of the bases occurring in coal tar. To-day, the American chemical industry has available in commercial quantities as individual chemicals, not as complex mixtures, the coal-tar bases: pyridine, alpha-picoline, beta-picoline, gamma-picoline, 2, 6-lutidine, 2, 4-lutidine, 2, 5-lutidine, quinoline, quinaldine, lepidine, isoquinoline, 3-methylisoquinoline, and acridine. Other coal-tar bases will be made available shortly.

The use of redwood tannin as a depressent for calcite and quartz in the flotation of felspar was described by William A. Manuel, Ohio Wesleyan University, Delaware, and Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wis. Quebracho tannin is being used in the flotation of felspar from calcite and silica. Preliminary experiments carried out by the Mahoning Mining Co., of Rosiclare, Ill., indicated that redwood tannin might be used in place of quebracho tannin but that three times as much by weight of the crude tannin would be required.

Redwood tannin has been found to vary greatly in its composition, and in view of these variations, a laboratory study was carried out at the Institute of Paper Chemistry to deter-

mine the relative effectiveness of the various redwood products. The results indicate that redwood rootwood tannin prepared by extracting the chipped and shredded rootwood with 95 per cent. alcohol, removing the alcohol under a vacuum, replacing it with water, filtering the insoluble phlobaphenenes, etc., and evaporating the water solution of the tannin under a vacuum at a temperature never in excess of 65°C., is equal to quebracho extract: in addition, tannin from the redwood cones is fully as good if not better.

Good separations have been accomplished by the use of 0.2 lb. of redwood tannin in 0.5 per cent. sodium carbonate per ton of ore in the conditioning period of the first stage of the flotation, with somewhat less in the two cleaning stages. Another redwood product of interest in this same application is a humic acid-like product which is the principal non-fibrous component of redwood bark.

Nitrocelluloses Alkyd Resin Lacquers

The evaluation of nitro-celluloses of very low viscosity in lacquers containing non-oxidising alkyd resins was the subject of a paper by Wm. Koch, Hercules Experiment Station, Hercules Powder Co., Wilmington. Four low-viscosity nitrocelluloses with viscosities of 19, 27, 33, and 40 centipoises, all below RS 1/4-second type, were evaluated in five selected compositions with each of four selected commercial non-oxidising alkyd resins for Sward rocker hardness, and temperature-change resistance after months of weathering. The data furnish ample evidence that satisfactory lacquers of the automobile-finishing type can be made by combining nitrocellulose having viscosities as low as 27 centipoises with alkyd resins. This limitation does not apply to resins such as drying oil types which are good film formers, where still lower-viscosity nitrocellulose is used to obtain quick-setting tack-free films.

Alfred E. Brown, W. G. Gordon, Edith C. Gall, and R. W. Jackson, Eastern Regional Research Laboratory, Philadelphia, gave an outline of the preparation and properties of acetylated casein fibre. Claims have been made in the patent literature that acetylation improves some of the inferior properties of protein fibre, including casein fibre, but as no report on a quantitative study of this problem has appeared, such an investigation was carried out with casein fibre made in this laboratory. Acetylation has been carried out with acetic anhydride under various conditions, and in the presence of catalysts. Acetyl contents ranging from 1 to 9 per cent. could be obtained by varying the time and temperature. Correlations between acetyl content and the following properties are reported: colour of fibre after acetylation, wet and dry tensile strengths, water content after immersion in water at 25°C., resistance to boiling solutions of different *p*H values, and dye affinity. Acetyl contents of about 6 per cent. could be introduced with no loss of wet or dry tensile strength, and fibres of such acetyl content are much superior to the untreated controls in regard to resistance to boiling solutions simulating dye bath conditions. They also have the desirable property of a greatly decreased affinity for acid dyes, and thus more closely approximate wool in dye uptake.

A new method for purifying lactic acid or preparing methyl lactate directly from crude aqueous lactic acid was described by E. M. Filachione and C. H. Fisher, Eastern Regional Research Laboratory, Philadelphia. In this process, methanol is passed through aqueous lactic acid and condensing the effluent vapours. The condensate, a mixture of methanol, water, and methyl lactate, can be distilled to recover the methyl lactate or hydrolysed to obtain purified lactic acid. Other esters of lactic acid can be prepared in a similar manner by using appropriate alcohols. The effect of certain variables on the volatilisation of lactic acid (principally as the methyl ester) with methanol vapour was studied. The time required to volatilise a given amount of lactic acid decreased as the rate of methanol addition was increased. Increasing the catalyst concentration (concentrated sulphuric acid) accelerated the operation. Approximately 9 moles of methanol were required to volatilise one mole of lactic acid from an 82 per cent. solution of the acid (kept at a temperature of 92° to 100°C.) over a wide range of methanol addition-rates. Although dilute lactic acid can be used, less time and less methanol were required to volatilise a given quantity of lactic acid from the more concentrated solutions.

U.S. SYNTHETIC RUBBER

According to an announcement made by the U.S. Rubber Director on February 17, $30,000,000—worth of improvements are to be made in plants producing synthetic rubber and its raw materials during the current year. Highest priorities have been granted to all of this scheduled production and installation. These projects are in no sense an expansion of the synthetic rubber programme but will simply put into effect certain minor additions and changes designed to bring about more efficient operation of some of the rubber units.

Of the total amount to be expended, $3,000,000 will be allocated to butadiene-from-alcohol facilities and $10,000,000 to butadiene-from-petroleum projects. Styrene plants will receive $3,000,000 and $10,000,000 will be spent on the improvement of copolymer plants. An additional $3,000,000 is being allocated to butyl rubber facilities and the balance—$1,000,000—will be spent on miscellaneous improvements to various units.

Gas Research Board

Recent Investigations and Advances

THE fourth annual report of the Council of the Gas Research Board contains, for the first time, a section incorporating short statements on each of the active research programmes, in the form of a review bringing the progress of the investigations up to October, 1943. Nearly all the research work has been carried out, as formerly, at Leeds University under the immediate direction of Dr. F. J. Dent, joint assistant director of the Board, and the general supervision of Professor D. T. A. Townend, Livesey Professor.

Complete Gasification

The results of the research on complete gasification can be summarised as follows:

(i) Coals and semi-cokes can be converted to gaseous and liquid hydrocarbons by the action of hydrogen under pressure. The reaction is strongly exothermic for both coal and coke.

(ii) In the case of coal the reaction, once initiated, travels rapidly through the coal, achieving carbonisation at a very high rate. Liquid hydrocarbons are also obtained in high yield and are of a "primary" character. The coke is finely porous and highly reactive

(iii) The process may be combined with others, *e.g.*, with one involving the production of hydrogen by the pressure-gasification of coke, or part of it, with oxygen and steam in a Lurgi generator; or with a process of methane synthesis from gaseous mixtures containing hydrogen and carbon monoxide; or with a process involving the sale of the reactive coke and the production of the necessary hydrogen by the breakdown of part of the rich gas made. All these will be explored after the gasification of coal with hydrogen under pressure has been achieved on the 300-scale.

Methane Synthesis

Work on the synthesis of methane has been carried on both at the Gas Research Board laboratories and at the Fuel Research Station. A preliminary exploration has indicated that a nickel catalyst made in a simple but effective manner is likely to give a satisfactory rate of conversion at a high space velocity. The behaviour of the catalyst has been explored at various temperatures, and the problem now remains of making the best choice of conditions for trial on a semi-technical scale. At the Fuel Research Station most of the work has been carried out using water gas. With water gas of a high H_2/CO ration, the most suitable catalyst for work at a relatively low temperature has proved to be a nickel catalyst promoted by thoria and supported on Kieselguhr.

For the use of catalysts of the above type, the removal of organic sulphur compounds from synthesis gas mixture is essential, to avert the poisoning of the methane-forming catalyst. With water gas, a copper-chromium catalyst, supported on active carbon, was developed at as low a temperature as 250°C.; purification in one stage reduced the sulphur content to 0.3 gr. and in three stages to 0.002 gr. per 100 cu. ft., which was sufficiently low for use in methane synthesis with a nickel or cobalt catalyst. With coal gas the copper-chromium catalyst is rapidly poisoned, apparently by unsaturated hydrocarbons, and must be protected by a hydrogenating catalyst of the molybdenum sulphide type.

The sulphur compound which chiefly escapes destruction is thiophen. Washing the purified gas with oil, particularly under pressure, will remove it, but this is not a practical method. It has been found, however, that a molybdenum sulphide catalyst can be prepared which will decompose thiophen at 300°C. almost completely.

Fractionating Coal Gas

For several years past at the Imperial College a group of workers under Sir Alfred Egerton has been investigating the liquefaction of methane and its use as a fuel. Latterly, a supply of methane, larger than that originally obtained from a colliery blow-hole (gas containing 97-98 per cent. methane) has been obtained by liquefying a gas mixture containing a high proportion of methane, and rectifying the liquid. Gas refrigeration and liquefaction are of particular interest as providing a ready means of separating the constituents of coal gas. The progressive cooling of coal gas in a liquefying plant can produce three important results:

(i) The removal of constituents normally removed by other means, *e.g.*, benzol. At the same time water vapour and organic sulphur compounds would be removed entirely.

(ii) The removal of valuable constituents at present burned in appliances, e.g., ethylene and propylene.

(iii) The removal of part of the methane for storage as a liquid during the summer months, for use in enriching water gas at periods of high demand.

Other research projects which are being actively carried on include: heating and drying by infra-red radiation; surveys of reactive coke and gas quality; the action of steam and carbon dioxide on carbon.

Colonial Products Research

First Annual Report

THE Colonial Products Research Council, which published its first interim report in December last year (THE CHEMICAL AGE, 1943, *49*, p. 612), has now produced its first annual report. This gives some details of the researches so far initiated into such matters as citrus products, clove oils, ergosterol, petroleum, sugar, theobromine, and vegetable oils. At its last meeting, it is stated, the Council arranged to start research on the chemical utilisation of timber. The research director (Professor J. L. Simonsen) and his personal assistant are making a survey of plants occurring in the Colonial Empire which may have therapeutic or other uses and which might repay detailed investigation. The Council is maintaining the closest touch with industry, and the research director has had numerous discussions with the more important firms interested in colonial products, and has also been in contact with research organisations overseas, notably in the Dominions and India, with the object of securing mutually profitable interchange of information and cooperation.

As announced in the interim report, the study of citrus products was assigned to Professor Heilbron's laboratory at the Imperial College of Science and Technology. The chemistry of the expressed oil is to be investigated there, and the chemistry of citral and related products is already being studied, preliminary results suggesting that this research may develop into a general examination of the possibility of using some of the more important constituents of the essential oils as raw materials for the chemical industry. The problem of concentrating lime-juice under conditions that would permit the retention of the normal flavour is being looked into with the collaboration of the Montserrat Co., Ltd. Clove oils are being investigated by Professor Clemo at King's College, Newcastle, with the aid of two assistants. Research is directed to determining whether any products of greater economic value than vanillin can be obtained from eugenol; three substances of possible therapeutic value have been prepared, and are now being tested. In view of the importance of this investigation to the economic future of Zanzibar and the Seychelles, it is hoped to expand the eugenol researches. Preliminary work on the extraction of ergosterol from yeast is being done at the Chemical Research Laboratory, Teddington; the objective is to develop a yeast containing a high content of ergosterol, and to devise an extraction process suitable for climates where the lower boiling solvents cannot conveniently be used.

Few oilfields have so far been developed within the Colonial Empire, but the Council has, in collaboration with the Trinidad Leaseholds, Ltd., begun research (under the direction of Sir Robert Robinson) on a problem suggested by the industry. Sugar research is being carried out in Birmingham University under the general direction of Professor W. N. Haworth, with Dr. L. F. Wiggins as research supervisor, and four assistants. As an outcome of preliminary work, improved methods have been devised for the preparation of two important degradation products, while provisional patents are being secured for certain simple derivatives of sucrose which may find application in plastics manufacture. Theobromine, which is available in large quantities, but is of little use outside beverage manufacture (it has a small therapeutic use as well), is being studied at Manchester University, where a number of substances have been prepared and submitted for therapeutic tests, while a highly-active degradation product is being investigated.

Fodder from Wood

Timber research has been referred to the Forest Products Research Laboratory, and will come under the immediately direction of Mr. W. G. Campbell. Preliminary experiments show that a carbohydrate suitable for cattle food can be obtained from wood; this process is considered to be uneconomic, however, until some use can be found for the effluent liquor from it. The research programme is to include a general investigation of chemical uses for timber other than in paper-pulp manufacture, and a general survey of secondary colonial timbers to determine their suitability for chemical treatment. This will mean long-term research of a highly speculative nature, but a successful outcome would exert a profound effect on the economic use of colonial forests.

Professor Hilditch and two assistants at Liverpool University are investigating various oil-bearing seeds; other aspects of vegetable-oil chemistry are under examination, including the presence of natural anti-oxidants and the convertion of drying oils into products of the tung-oil type. Further researches into oils and fats, started by the late Dr. Smedley-MacLean, are being carried out by Mr. E. Reid at Imperial College, under the supervision of Professor Heilbron and Dr. E. R. H Jones. The total cost of all these researches up to March 31, 1944, is £3247; salaries and expenses of the headquarters staff account for a further £3008.

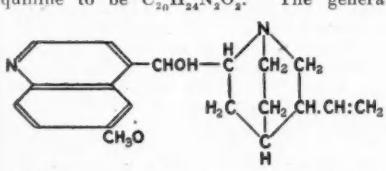
The olive oil industry of Argentina, which is relatively new, made great strides in 1943 and, as a result of many new plantations, output reached 640,000 litres of oil.

The Synthesis of Quinine

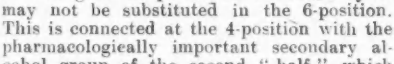
A Survey of Progress

IT is now 124 years ago since Pelletier and Caventou separated the crystalline substance obtainable from cinchona bark into its two principle constituents—quinine and cinchonine. Within a year of its isolation the pure alkaloid was introduced into medical practice and it was being manufactured by the firm of Howards in 1823. The alkaloid was not official in the 1824 edition of the *Pharmocopœia Londoniensis* but became so in the next one, in 1836. In 1854, Whiffen and Herring started the manufacture of quinine salts at Battersea, utilising a process devised and patented by the latter in 1853 in which the use of alcohol was obviated. So, again, as in the case of morphine and, later on, with the dyestuffs, the prohibitive cost of alcohol deeply effected the industry and became a potent cause in the decline of the British chemical industry as a whole.

A great deal of attention was paid to the determination of the molecular formulæ of naturally occurring principles in the early years of the 19th century. Liebig, who was a leader in this field, and, indeed, established the method and technique, found quinine to be $C_{20}H_{24}N_2O_2$. The general



structure of the quinine alkaloids was worked out by Skraup, Königs, von Müller, Rohde, and Rabe between 1880 and 1909. By degradative methods the molecule was shown to consist of two "halves." The first "half" is a quinoline nucleus which, according to the particular alkaloid may or may not be substituted in the 6-position. This is connected at the 4-position with the pharmacologically important secondary alcohol group of the second "half" which consists of a cyclic amino alcohol carrying the secondary alcohol chain mentioned and a second chain which may be ethyl or vinyl according to the alkaloid. The general plan is:—



In quinine R = methoxy and R′ = vinyl. The alkaloids of cinchona bark are optically active, and quiniline, for example, is the stereoisomer of quinine.

In 1856—long before its constitution was known—W. H. Perkin made the gallant attempt to synthesise quinine which ended unexpectedly and spectacularly in the production of *mauve*, the first aniline dye. Thereafter, attempts at synthesis awaited the fuller determination of structure. This was stimulatd by Laveran's discovery of the specific action of quinine on the malaria parasite in 1880 and the later recognition of its action on the schizont stage to which the external manifestations of malarial attacks are due. Two main lines of development have been followed: firstly, the preparation of derivatives of quinine, principally with the objective of eliminating the bitterness of the alkaloid; secondly, the production of chemotherapeutic analogues of simpler structure which have owed their pattern more to that of the antimalarial methylene blue than to the more complex quinine.

Rabe and Kindler's Researches

Attempts to synthesise the actual quinine molecule, however, were not abandoned, and in 1918 Rabe and Kindler achieved a partial synthesis starting from quinicine (or quinotoxin). This starting material was an already complex base in which the two "halves" of the quinine alkaloids were already implicit. It was, in fact, obtained through degradative changes from quinine itself by treatment with acetic acid under specific conditions which led to the conversion of the secondary alcohol "link" to carbonyl and to the rupture of the quinuclidine ring. While this work was mainly of importance in characterising the structure of the quinotoxins, it opened the way to the synthesis of quinine through quinicine from cinchononic acid and 4-methyl-pyridine. This was actually achieved by Rabe in the early 1920's but his synthetic differed from quinine to the extent that it lacked the vinyl side-chain in the quinuclidine nucleus. Since those days research workers seem to have been preoccupied with what are generally described as "synthetic antimalarials" to distinguish them from the naturally occurring cinchona alkaloids.

Brief news has now come from U.S.A. that the synthesis of quinine has now been finally accomplished, and workers in the alkaloid field await fuller information with interest. To what extent the mepacrine position is likely to be effected remains to be seen. The practical obstacles may still be sufficiently great to prevent commercial exploitation even in a world devoid of the natural product.

Ceramics To-day

War-time Substitution for Metals

CERAMICS are being used by manufacturers in place of plastics, steel, nickel, copper, aluminium, zinc, and rubber. High-strength porcelain, porcelain enamel, vitreous china, stoneware, and other fired products of modern ceramic art are very different from the "white ware" of the past. Present day industrial "white ware" has characteristics that make it highly suitable for many industrial uses. Outstanding among these qualities is resistance to abrasion. Almost the only materials that outwear white ware are rubber-tyre tread stock and manganese steel. In fact, for some exacting uses, such as nozzles for sandblast equipment, it has been found that the best ceramic nozzles will outlast manganese steel, while for the lining in coke chutes, hard vitreous tile will still be in good condition when both steel and rubber linings are worn out.

In comparisons of compressive strength it is to be noted that the range for ceramics is 25,000 to 80,000 lb./sq. in. This compares with 9000 to 47,000 for aluminium alloys, 16,500 to 45,000 for thermosetting plastics, 7000 to 20,000 for zinc alloys, and 55,000 to 400,000 for ferrous alloys.

For tensile strength, ceramics do not make such a good showing at 1500 to 10,000 lb./sq. in. This compares with 13,000 to 68,000 for aluminium alloys, 6000 to 20,000 for thermosetting plastics, 7000 to 13,000 for zinc alloys, and 40,000 to 400,000 for ferrous alloys. This deficiency in tensile strength can, however, often be made up by increasing the thickness or other dimensions of the ceramic unit. With low-cost raw materials this is possible where it would be out of the question with substances in relatively short supply.

Chemical Resistance

Resistance to chemicals is a prominent feature of ceramics. They will withstand almost any compound except hydrofluoric acid. In hardness, they exceed most plastics, hard rubber, most non-ferrous metals, are equal to glass, and softer than alloy steels and chilled cast iron.

An obstacle to the use of ceramic parts as substitutes for metal in complicated assemblies is the shrinkage and occasional warping that takes place during firing. Such shrinkage is of little consequence in the manufacture of table ware or kitchen ware, or even in floor and wall tiles, where inequalities can be evened out by the use of a little more or a little less cement in setting. But in electrical assemblies, when metal and porcelain parts must fit with fine tolerance, the requirements are quite different. However, dimensional tolerances sufficiently fine have been obtained by several newer moulding methods. One method, now over ten years old, moulds a part in the traditional manner but somewhat oversize. A preliminary firing shrinks the part to a certain extent but leaves it still oversize. The first firing is stopped while the material is still soft enough to machine with standard machine tools. The machining is done to allow an exact margin for the additional shrinkage that occurs during the second and final firing.

In another method, exact parts are obtained by machining rods and sheets, up to one inch thickness, of fused mica and glass. Mica and glass are not fired during the forming process because, unlike true ceramics, this compound softens at high temperatures. But the mica-glass material can be used like porcelain and has the advantage of machinability and can be pressure-moulded like plastics.

About a year ago, a process of moulding true ceramics in accurately-dimensioned steel moulds was perfected. These moulds are oversized in exact proportion, so that, on shrinking, the final product is of the desired size. In this process carefully blended and moistened clays are moulded under such heavy pressure that warpage is practically absent and the result is a dense, high-strength product. The fired product can be held to an accuracy of 1/64 in. per inch of dimension, and further exactness can be obtained by grinding.

"CIBA" ANNUAL MEETING

At the annual meeting of CIBA, held at Basle, the chairman, Dr. Staehelin, after a tribute to the late president, Dr. Brodbeck-Sanreuter, referred to the fact that the company's research work was being carried on steadily in order to be ready for the post-war requirements. Its results had still to be applied in industry. He was confident that war-time achievements in research would provide a safe guarantee of the company's post-war position. Dr. Käppeli, a director, remarked on the decline in the sales of dyestuffs due to the fact that most of the continental markets were now self-sufficient. Sales in overseas markets could not compensate for this decline. However, thanks to an increase in the sale of special pharmaceutical products, and to a satisfactory domestic demand for various chemical products and for substitute materials, the decline in the sale of dyestuffs had no serious repercussions on the financial results.

The Sulphonamides

Institute Lecture by Dr. Phillips

A LECTURE entitled "Recent Advances in Sulphonamide Therapy" was delivered by Dr. M. A. Phillips, research director of Bayer Products, Ltd., at the meeting on May 17 of the London and S.E. Counties section of the Royal Institute of Chemistry. After briefly surveying the historical development of the sulphonamides from "Prontosil" Rubrum, "Prontosil" Soluble and the discovery of sulphanilamide as the active part of the molecule of the sulphonamide dyestuff, Dr. Phillips referred to modern derivatives of sulphanilamide. Of these, the best known, perhaps, was 2-(*p*-amino-benzene sulphonamide)—sulphapyridine or "M & B 693"—first made by Dr. Ewins and himself in 1937. This compound, however, had proved to have certain deficiencies, particularly with regard to its toxic effects; it was also not very helpful for staphylococcal infections, although its action on pneumococcus was well known. Sulphathiazole—2(*p*-aminobenzene sulphonamido)-thiazole—and sulphadiazine—2(*p*-aminobenzene sulphonamido)-pyrimidine—were more recent developments from sulphapyridine.

After dealing with the chemistry of these compounds and of other sulphonamides such as sulphamethazine (sulpha-dimethyl pyrimidine), sulphaguanidine, sulphasuxidine (succinyl sulphathiazole) and sulphacetamide (*p*-amino benzene sulphonacetamide), the lecturer called attention to the following grouping which is common to all the above drugs; this may or may not have chemotherapeutic significance:

$$-SO_2-NH-C\begin{matrix}\diagup N- \\ \\ \diagdown X-\end{matrix}\begin{matrix}X=C\\ \\ X-\end{matrix}$$

S Sulphathiazole
N Sulphadiazine,
Sulphamethazine,
Sulphaguanidine.

Sulphaguanidine and sulphasuxidine, he said, were useful as bacillary disinfectants and *p*-aminobenzene sulphonacetamide was one of the few sulphonamides forming a neutral sodium salt.

Both sulphathiazole and sulphadiazine, said Dr. Phillips, have advantages over sulphapyridine in being less prone to untoward sequelæ and in being more active against staphylococcal infections.

Regarding the mode of action of the sulphonamides, Dr. Phillips referred to past theories, now discredited, such as stimulation of phagocytosis, destruction of the bacterial "envelope," etc. Modern views accept *bacteriostasis* as the primary action of sulphonamides; this is believed to be caused by interference with bacterial metabolism. Exactly how this occurs is not known, but Dr. Phillips referred to the antagonism of *p*-amino benzoic acid by sulphonamides and to the work on this aspect of the matter by Wood, Lockwood, McIlwain, *et al.* Although there was much to be said for this theory, it was by no means proven and, in its simplest form, it did not account for the specificity of drug action, or for the phenomenon of sulphonamide resistance. Domagk has recently published work which, he asserts, is not in accordance with the sulphanilamide/*p*-amino benzoic acid hypothesis, and it is clear that much more work remains to be done in this field. The lecturer referred briefly to the work he hoped to do on lipophilic sulphonamides in connection with the T.B. problem.

Parliamentary Topics

Chemicals from Sea Water

IN the House of Commons recently Mr. Ellis Smith asked the Minister of Production if he could make a statement on the experience gained in practice and research in the extraction of material and chemicals from the sea; what results had been obtained; if it was intended to speed this up as a contribution to the development of our post-war economy; and if he would give an assurance that no person or groups would be allowed to impede development and output in any form. The Parliamentary Secretary to the Ministry of Production, Mr. Garro Jones, replied that though the valuable developments which had taken place were primarily directed to war purposes, he could give an assurance that the post-war aspects were not being overlooked.

Synthetic Rubber

Mr. Hammersley asked the Minister of Supply under what authority the Rubber Control had issued an instruction that no firm would be supplied with synthetic rubber unless they agreed to disclose the details of the whole of their present and future processes to the industry. Sir Andrew Duncan informed the questioner that no such instruction had been issued.

Government Scientists' Pay

Mr. Salt asked the Chancellor of the Exchequer what steps had been taken to increase the salaries of the directors of Government research establishments; and how their present salaries compared with those paid before the changes were made. Sir John Anderson answered that there had been no general change in the remuneration of the Directors of Government Research Establishments as such. It was, however, recently decided to bring up to a salary level of £2000 a certain number of scientific posts which required outstanding professional qualifications, and involved specially heavy administrative responsibilities.

National Arbitration Cases

I.C.I. v. Riggers Dispute

TWO trade disputes, both between riggers employed at I.C.I. works and the company, have been settled by the National Arbitration Tribunal. In the first (*National Arbitration Tribunal Award No.* 541, H.M.S.O., 1d.) the workmen involved were members of the Transport and General Workers' Union employed by I.C.I. (Fertilisers and Synthetic Products), Ltd. The dispute arose out of a claim by the riggers: (1) that they should be paid a minimum of 1s. 11¾d. an hour; (2) that they should be afforded craft status similar to that of fitters at the same works, and receive merit payments on the same basis as the fitters; (3) that they should not be called upon to do work other than rigging. The tribunal, held in London on April 18, found against the first and third claims; on the second claim it was held that craft status should not be granted, but that the rate at present paid to riggers should be treated as a minimum rate and riggers should in future be eligible for additional individual merit payments, to be determined in the same way as merit payments already made by the firm to craft workers. The other tribunal was held on May 3 (*Arbitration Award No.* 551, 1d.), the parties concerned being I.C.I., Ltd., Welwyn Garden City, and members of the Constructional Engineering Union. The dispute arose from claims by the workmen that (1) members of the Union employed as riggers by I.C.I., Ltd., under the title of "Agents for Construction, I.C.I., Ltd." at three works, should continue to receive the rates of wages they received prior to June, 1943, and deductions made since that date should be repaid to them or, alternatively, (2) from June 1943, the rates and conditions of the workmen should be in conformity with the agreement between I.C.I., Ltd., and the National Federation of Building Trade Operatives. This tribunal found that the claim had not been substantiated.

Scottish Firms Concerned

Other claims recently dealt with by the Tribunal concerned two Scottish firms of chemical manufacturers. The first claim—for payment at the rate of time-and-a-half retrospectively as from March, 1942, for all overtime worked by shiftworkers—was made by members of the National Union of General and Municipal Workers employed at Falkirk and Glasgow by the Scottish Tan Distillers, Ltd. The firm gave evidence to the effect that prior to March, 1942, the overtime rate of time-and-a-half was paid in respect of the last 4 hours in cases where men were required to work two 12-hour shifts. As from March, 1942, the ocertime rate for the first two hours' overtime was reduced to time-and-a-quarter. The Union put forward the contention that the firm had no right to alter their pre-March, 1942, overtime conditions without agreement with the Union or the workpeople.

The Tribunal ruled that payment of all overtime to the shift workers concerned should be on the basis of time-and-a-half, this award to have effect from the beginning of the next full pay period. Full details of this award (No. 548) are published as a leaflet by H.M.S.O., price 1d.

The other arbitration concerned a dispute between John and James White, Ltd., of Rutherglen, near Glasgow, and members of the National Union of General and Municipal Workers employed by the firm. The workmen claimed they did not receive a 3½d. per hour increase to which they considered themselves entitled. The Tribunal, after investigating the case, came to the conclusion that the claim had not been established and awarded accordingly. (*National Arbitration Tribunal, Award No.* 549, H.M.S., 1d.)

Ketone Motor Fuels

Based on Fermentation

THE first ketone motor fuel, known as "Ketol," to be introduced into industry is obtained by dry distillation of the calcium salt of organic acids from the butyric acid fermentation of sugar solutions. This product, a clear liquid of unpleasant odour with a calorific value of 9.2 calories per gm. is a mixture of acetone, propyl ketone and other ketones with varying amounts of isobutyl and amyl alcohols and aldehydes.

Fischer's "Synthal" contains ketones, including acetone. Recent investigations have shown that acetone is suitable for motor fuel. It has an octane number of 98, latent heat of vaporisation of 526 joules per gm., and a calorific value of 6.959 calories. Also suitable are certain of the higher homologues of acetone, including methyl ethyl ketone, which has an octane number of 99. Lower ketones are especially suitable as blending agents for aviation fuel. A mixture of 30 parts of ketone, 70 parts of gasoline and 0.6 parts of tetraethyl lead has an octane number of 100. Italian patent 350,427 describes a process for making acetone oil by fermentation of molasses to lower fatty acids and then catalytically ketonising the acids in the vapour phase at 300 to 500°C. with steam.—Digest published in *Chem. Met. Eng.* (1944, 51, 3, p. 191) from "Ketone Motor Fuels," *Oel und Khole in Gemeinschaft mit Brennstoff-Chemi*, 1943, 39, Sch. 138).

Personal Notes

PROFESSOR MICHAEL POLANYI, F.R.S., professor of physical chemistry at Manchester University, has been elected president of the Manchester Literary and Philosophical Society.

MR. F. J. DU TOIT, secretary for Commerce and Industries, has been appointed chairman of the National Supplies Control Board for the Union of S. Africa in the place of MR. E. P. SMITH.

The following are the officers of the new Bristol section of the Oil and Colour Chemists' Association: *Chairman*, MR. W. G. WADE; *hon. secretary*, MR. J. T. PEACOP; *hon. treasurer*, MR. R. C. CRANE.

MR. A. B. PITCHER, chief accountant of the Imperial Smelting Corporation, Ltd., and its subsidiary and associated companies, has been appointed secretary of the company in place of Mr. F. V. Thomson who has resigned to become secretary of British Insulated Cables, Ltd.

MR. G. COPPING is severing his long connection with the journal of the Oil and Colour Chemists' Association. His resignation, necessitated by the pressure of other work, takes effect on June 30, after which date MR. A. J. GIBSON, hon. organising secretary of the O.C.C.A. will take over his editorial duties.

SIR ARDESHIR DALAL, director-in-charge of the Tata Iron and Steel Co., Ltd., has been placed at the head of the new Department of Planning and Development, with a seat on the Governor-General's executive council. Sir Ardeshir is a co-author of the "Bombay Plan" for economic development of the country, which a number of leading Indian industrialists drew up recently.

This year's chairman of the Ottawa Section of the Society of Chemical Industry is MR. A. KEITH LIGHT, chief of the National Research Council's analytical laboratory. For the past six years he has served as secretary of the Ottawa Section. A graduate of Queen's University, he gained experience with the Mond Nickel Co. and the Delors Smelting Co. before joining the Government service.

DR. W. W. SKINNER, chief of the U.S. Department of Agriculture's Bureau of Agricultural and Industrial Chemistry, has retired from that position, after a career in the federal service lasting 40 years. He played an active part in establishing the department's four Regional Research Laboratories—a year ago an article on these laboratories appeared in THE CHEMICAL AGE (1943, *48*, p. 505)—and other research centres in which the industrial and food uses of farm products are studied, and during this war he has seen this type of research on pilot-plant scale abundantly justified.

Obituary

DR. ARTHUR RENWICK MIDDLETON, emeritus professor of Purdue University's chemistry department, died on February 7 at the age of 75.

The death is reported of DR. HARRY FLETCHER BROWN, vice-president and director of the Du Pont Co. of America, on February 28 at the age of 76. He was chief chemist of the International Smokeless Powder and Chemical Co., when it was taken over by Du Pont. Some time ago Dr. Brown gave $400,000 to the University of Delaware for a new chemistry building.

Instrument Technology

New Society Formed

WITH the title of "The Society of Instrument Technology," an organisation has been formed for those interested in the design, manufacture, use and maintenance of scientific instruments. Its objects are:

(a) Advancement of instrument technology by the dissemination and co-ordination of information relating to the design, application, and maintenance of instruments.

(b) Provision of opportunities for discussion, particularly between designers and manufacturers on the one side, and users on the other.

(c) Provision of opportunities for discussion, and collaboration between the Society and other associations.

(d) Encouragement of technical education for those who wish to enter, or are already in, the industry.

(e) Encouragement of research into problems relating to instrument technology.

(f) Encouragement of the standardisation of instruments and accessories by collaboration between manufacturers and users.

(g) Determination of a commonly acceptable terminology.

(h) Enhancing the status and prestige of those employed in the industry.

Members of Council and officers are: *President*, Sir G. P. Thomson, M.A., F.R.S.; *Members of council*: Dr. W. J. Clark, Mr. G. H. Farrington, Dr. W. F. Higgins, Mr. W. B. Wright, Mr. C. R. Sams, Mr. E. B. Moss, Mr. R. E. Iggledon, Mr. F. C. Knowles, Mr. D. A. Oliver, Dr. H. S. Gregory, Dr. E. Griffiths, and Professor F. Debenham; *hon. treasurer*, Dr. H. B. Cronshaw; *hon. secretary*, Mr. L. B. Lambert, 55 Tudor Gardens, London, W.3.

Those interested are invited to send their name and address to the hon. secretary, who will forward details of membership and an application form. It is intended to call a general meeting, probably in the early autumn, at which the constitution and rules, as recommended by the council, will be submitted for formal approval.

General News

The I.C.I. film about Monastral Blue was shown at the meeting of the Hull Section of the Oil and Colour Chemists' Association on Tuesday.

Specification DTD 390, for aluminium-coated aluminium alloy sheets and coils, has been reprinted, Amendment List No. 1 being incorporated, and is available from the Stationery Office, price 1s.

A Bristol section of the Oil and Colour Chemists' Association will be formally inaugurated at a meeting to be held at the Merchant Venturers' College, Unity Street, Bristol, on June 23, at 6.15 p.m.

A new mineral from North Wales was described at the meeting of the Mineralogical Society on June 8. A barium-felspar, for which the name *Banalsite* has been proposed, it is composed of unit cells with the formula $Na_8Ba_4Al_{16}Si_{16}O_{64}$.

The discovery of boracite as a minor constituent of interbedded salt and anhydrite belonging to the saliferous marl series of the Permian was reported by Miss E. M. Guppy to the last meeting of the Mineralogical Society. The find was made in a boring taken from Aislaby in Yorkshire.

The iron ore deposit on the outskirts of Dalbeatie, Scotland, may be worked again, suggests the *Glasgow Herald*. The mine gave employment to many people when it was operated some 40 years ago. Random samples of ore taken recently are said to have an iron content of 65 per cent.

The Kestner Evaporation and Engineering Co., Ltd., has issued a new leaflet—No. 269—dealing with the pumping of corrosive liquors. One of the most interesting items in it is the new patent self-priming glandless centrifugal pump, which is capable of handling all corrosive chemicals, including hydrofluoric acid.

The Safeguarding of Industries (Exemption) No. 1 Order, 1944 (S.R. & O. 1944, No. 595), which is effective from May 31 to June 30, 1944, exempts from Key Industry Duty the following acyl derivatives of urea: iso-amyl ethyl barbituric acid; sodium iso-amyl ethyl barbiturate; and sodium propyl-methyl-carbinyl allyl barbiturate.

A technical survey of the ironstone industry of Northamptonshire, Lincolnshire, and adjoining counties is to be made by Mr. A. H. S. Waters, M.Inst.C.E., M.I.Mech.E., on behalf of the Minister of Town and Country Planning. He will report on the scope and efficiency of present measures for restoring land damaged by quarrying, and also on possible extension and improvement of these methods.

From Week to Week

Concern at an increase of dermatitis in the industry was expressed at the National Union of Dyers, Bleachers, and Textile Workers' conference. A resolution was passed requesting the executive committee to approach the Minister of Health and the Home Office for more effective measures to prevent industrial diseases.

A small committee has been formed, including representatives of the Mineralogical and Geological Societies, with the object of furthering the manufacture of petrological microscopes in this country. The committee would welcome comments from any persons interested, to be addressed to the Secretary, P.M.C., Geological Survey, Exhibition Road, S.W.7.

Lord McGowan, speaking at the annual meeting of I.C.I., Ltd., on Tuesday, welcomed the Chancellor of the Exchequer's proposed concessions for expenditure on research and development. He commented favourably on the expansionist policy expressed in the Government White Paper on employment, saying it gave industry a firm foundation on which it could confidently exercise its responsibility and initiative.

The first Mercer Lecture of the Society of Dyers and Colourists was delivered in Manchester on May 19 by Messrs. N. G. McCulloch and G. S. Hibbert, of the Calico Printers' Association. Their subject was "Science in an Old Industry." The lecture was devoted to a *résumé* of the career of John Mercer, the inventor who became F.R.S. in 1852, and to an appeal to industry to follow his example in showing a spirit of inquiry and progressiveness.

The Dunlop chairman, Sir George Beharrell, in the statement issued with the annual accounts, says: "I have seen nothing that would make me long for the day when we should go for 100 per cent. synthetic rubber rather than 100 per cent. natural rubber." He adds that additional machinery introduced to deal with synthetic supplies could be utilised in normal circumstances, since the need for its introduction had arisen from the slower working of synthetic as compared with crude rubber.

Foreign News

Caustic soda is being distributed in Bulgaria for household cleaning purposes owing to shortage of soap.

A pilot plant costing 300,000 rupees has been set up by the Ceylon Government for the production of acetic acid from coconut shells, a process expected to compensate for the serious decline in the demand for coconut-shell charcoal.

Many workers were injured last week when an explosion wrecked the ammonia plant of Canadian Industries, Ltd., at Windsor, Ontario.

Portuguese wolfram exports to Germany are to stop, it is reported from Washington. The same source states that Portugal will now be closing down its wolfram mines.

The Aluminium Company of America (Alcoa) earned in 1943 a net income of 43 million dollars, equal, after preferred dividends, to $7.95 a share. The amount of aluminium produced by the company last year increased 78 per cent. over 1942, which in turn was 50 per cent. larger than in 1941.

The Bulgarian Government is subsidising the synthetic rubber factory of Proiswodstow-Plaisment to encourage production of this material which is needed for footwear. Bulgarian production of synthetic rubber was reported a year ago to amount to 2 cwt. a day.

Large supplies of synthetic vitamins have been distributed to famine victims in Bengal, stated the Secretary of State for India recently. He added that plans for the production of food yeast and its use in civil and military diet were before the Indian authorities.

The production rate of 4,879,100 barrels daily of all petroleum liquids allowed by the Petroleum Administrator for Wart to the various oil-producing States in the U.S.A. for June, 1944, is a record figure, and represents a net increase of 60,600 barrels daily over the rate certified for May.

Industrial use of silver was largely responsible for the huge consumption of the metal—118,000,000 oz.—by the United States in 1943. Imports of silver, mainly from Mexico, declined last year by 45,000,000 oz. to 63,000,000 oz., the deficit being made good by the release to industry of some of the stocks of the U.S. Treasury.

Canadian chemists favour a single national organisation which, it is expected, will be provisionally established this week at the Canadian Chemical Conference in Toronto. Ballot papers with regard to this proposal were sent to 1600 chemists and chemical engineers, of whom 95 per cent. voted for the setting up of such a body, to be tentatively named "The Chemical Institute of Canada."

The Rumanian oil centre of Ploesti was attacked by strong forces of heavy bombers—a figure of 500-750 planes was given, not including the escorting fighters—on May 31. At least one major oil refinery was hit. Annual output of all the Ploesti refineries, it is estimated, has been reduced by allied air attacks to 2,000,000 tons, as against 9,000,000 tons at the beginning of April. Only one plant is now capable of any substantial production.

A grant to finance preparatory work towards reopening the Paposo copper mines, Taltal, Chile, which had been closed owing to poor transport facilities and lack of essential materials, is being made by the Chilean Corporation for development of production, according to Reuter.

A yield of 5-10 per cent. of crucible-grade graphite appears to be recoverable by flotation from an average type of Tanganyika graphite-schist. The Director of Sundry Materials, London, is preparing a final pronouncement on the quality of the flotation produce (*Bull. Imp. Inst.*, 1944, *42*, 1, 52).

The report on "Crop Production and Soil Fertility Problems," in the Leverhulme Trust's volume of Technical Reports on West Africa, has been prepared by Mr. H. C. Sampson, B.Sc., C.I.E., and Dr. E. M. Crowther, D.Sc., F.R.I.C., head of the chemistry department at Rothamsted.

The Consilidated Mining and Smelting Company of Canada is carrying on preliminary work on a power site on the Nation River in the Cassiar District to provide hydro-electric power over a 60-mile transmission line to its Pinchi Creek mercury property.

Bethlehem Steel Corporation of America discloses that development work has begun on its Venezuelan iron-ore concessions. A group of sixteen concessions in the State of Bolivar, and known as the Elpao mines, are involved, and the first ore is scheduled for shipment in about six months' time.

Forthcoming Events

The **Institution of Factory Managers,** South Eastern (London) branch, will meet at the Bonnington Hotel, Southampton Row, London, W.C.1, on **June 17,** at 2.45 p.m., when a discussion will take place on "Current and Future Problems in Factory Management."

The Association of Austrian Engineers, Chemists and Scientific Workers meets on **June 19,** at 7.15 p.m., at the Institution of Mechanical Engineers, Storeys Gate, Westminster, to hear a lecture by Professor P. H. Gross entitled "Planning and Education for Technical Research."

Company News

Derbyshire Stone, Ltd., report a net profit, after tax, of £40,250 (£40,026). Dividend on ordinary shares is again 10 per cent.; forward, £62,058 (£56,823).

British Alkaloids, Ltd., report a profit, to March 31, of £187,768 (£128,820), and are carrying forward £6958 (£2030). The dividends have already been recorded.

British Oxygen Co., Ltd., announce dividends on 6½ per cent. cum. pref. stock and 5 per cent. cum. second pref. stock for the half-year ending June 30, less tax at 9s. 8d.

Stevenson and Howell, Ltd., have declared a final dividend of 8 per cent. on ordinary shares, making 13 per cent. in all (unchanged). Trading profit was £53,841 (£62,511); forward, £55,038 (£52,797).

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

BALLA PRODUCTS CO., LTD., London, E.C., chemical manufacturers, etc. (M., 10/6/44.) May 16, £600 debentures, part of a series already registered.

BRITISH CELANESE, LTD., Torquay. (M., 10/6/44.) May 17, £1,000,000 debenture stock together with a premium of 2 per cent. in certain events secured by a Trust Deed dated May 1, 1944; general charge (subject, etc.). £3,122,761. January 4, 1944.

Declaration of Solvency Filed

WITTY & WYATT (CARDIFF), LTD., asbestos manufacturers. (D.S.F., 10/6/44.) May 11.

Chemical and Allied Stocks and Shares

ALTHOUGH less active, stock markets have been firm. Recent gains in industrial shares were quite well maintained. News of the fusion of the plaster board interests of the Distillers Company with those of the British Plaster Board Co. was followed by a strong advance in the 5s. shares of the latter company to 34s. 4½d., while Distillers Units further advanced to 97s. 6d. This deal tended to draw attention to the widespread interests of the Distillers Co., whose dividend announcement, now impending, is generally expected to show maintenance of the distribution at 16¼ per cent. for the past year.

Borax Consolidated deferred were higher at 36s. 6d., it being pointed out that a not unattractive yield is shown on last year's 7½ per cent. dividend. General Refractories 10s. ordinary further improved to 17s. 6d. on hopeful views of post-war prospects. General Electric rose further to 95s. 3d. for a similar reason, as did Triplex Glass at 42s., and Lever and Unilever at 36s. Moreover, Turner and Newall showed firmness at 84s. 10½d., as did Wall Paper Manufacturers deferred at 43s. 6d., United Molasses at 34s. 10½d., and Pinchin Johnson at 37s. 9d.

Imperial Chemicals have been active around 39s. 9d. B. Laporte were 82s. 6d., W. J. Bush rose to 63s. 9d., and Greeff-Chemicals 5s. ordinary held their rise to 8s. Improvement to 41s. 3d. was shown in British Match, British Oxygen rose further to 83s. 3d., and De La Rue were firm at 186s. 3d., awaiting the dividend announcement. Textiles were good, with Bradford Dyers 23s. 9d., and Calico Printers 16s. 6d. Iron and steels were more active, with United Steel 27s. 3d., Dorman Long 28s., Staveley 52s. 9d., Stewarts and Lloyds 55s. 9d., and Tube Investments 96s. 9d. Babcock and Wilcox were 51s., and Allied Ironfounders 54s. Talk of a higher dividend maintained activity around 9s. 6d. in Consett Iron 6s. 8d. units. British Industrial Plastics 2s. shares have continued to change hands around 7s. 3d. and Erinoid 5s. ordinary were again 11s. British Drug Houses changed hands up to 26s. 3d., Burt Boulton around 23s. 6d., Fisons up to 52s. Goodlass Wall 10s. ordinary were 17s. 6d., and Lewis Berger showed dealings up to 104s. British Glues 4s. ordinary were firm at 8s. 9d. awaiting the dividend announcement.

United Glass Bottle remained firm at 68s. 9d., as did Forster's Glass 10s. ordinary at 32s., the latter on the maintained distribution of 15 per cent. Leeds Fireclay ordinary were better at 7s. Blythe Colour 4s. ordinary were 10s., and Cellon 5s. shares 23s. Boots Drug 5s. ordinary moved higher at 44s. 6d., reflecting the upward trend in stores and allied shares, while Sangers were 27s. 1½d., Timothy Whites higher at 35s., and Beechams deferred were firm at 18s. Elsewhere, Gas Light and Coke were 21s. 3d., and Murex 106s. 3d. Barry and Staines improved to 48s. awaiting the forthcoming results, and Nairn and Greenwich were higher at 76s. 9d. Dunlop Rubber became less firm at 43s. 6d. now the full results have been issued, but Avon India Rubber at 40s. 6d. responded to talk of an improved dividend, and British Tyre and Rubber changed hands up to 52s. Monsanto Chemicals 5½ per cent. preference were again 23s. William Blythe 3s. ordinary remained firmly held and were quoted at 9s., while Lawes Chemicals were dealt in at close on 13s. Awaiting the dividend announcement, British Thermostat shares were more active up to 21s. 3d.

After rising to 66s., Associated Cement eased to 65s. 6d., while Tunnel Cement were 52s., and Alpha Cement 5s. shares 10s. 9d. International Combustion changed hands at 132s. 6d. Oil shares have reflected the up-

ward trend of markets, with "Shell" 81s. 6d., Trinidad Leaseholds 97s. 6d., and Anglo-Iranian 118s. 9d. Ultramar rose to 70s. 3d. on the announcement that preliminary well-tests were satisfactory. British Controlled issues were steady following the capital scheme forecast.

British Chemical Prices

Market Reports

QUIET conditions prevail in most sections of the chemical market this week, and no changes of importance have been reported. New business continues to be regulated by the supply position, although deliveries against contracts remain steady. In the soda products section, offers of chlorate, bichromate and prussiate of soda are scarce and quotations are strong, while firm prices are ruling for soda ash, Glauber salt and salt cake. The steady inquiry for supplies of hyposulphite of soda and phosphate of soda continue. In the potash section of the market, there has been no noticeable improvement in the supply position of either bichromate of potash or caustic potash. Acid phosphate of potash is a good market, and offers of permanganate of potash are readily absorbed. Formaldehyde remains a good market, and in the acid section there is perhaps a more active inquiry for boric and acetic acids. There has been no outstanding feature in the coal-tar products market this week and inquiry for new business has been on a moderate scale. A steady inquiry is reported for creosote oil, and crude and refined tar, while the xylols and naphthas are being taken up in fair quantities.

MANCHESTER.—Strong price conditions obtained throughout the Manchester chemical market, and trading has been on a somewhat brisker scale after the holiday dullness of last week. Deliveries under contract have proceeded with little interruption, and an increase in the volume of inquiry has resulted in moderate new business. Good quantities of the general run of alkalis are being taken up, while steady trade is reported in alum, sulphate of alumina, and ammonia products. Calcine of magnesia and carbonate of magnesia are in fair request. Most of the leading heavy and light tar-products are going into consumption in good quantities and at firm prices.

GLASGOW.—In the Scottish heavy chemical trade during the past week business for the home trade has been rather quieter. Export inquiries still remain rather limited. Prices keep firm at previous levels.

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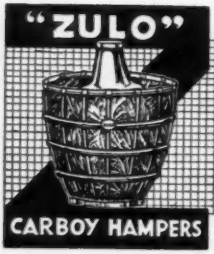
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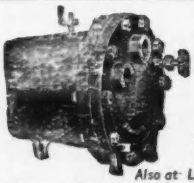
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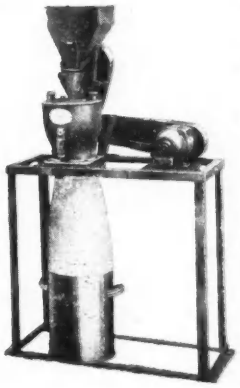

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